ENGINEERING NEWS

A CORRESPONDENT of the Montreal *Gazette*, who has revisited Panama after an absence of four years gives his observations at Culebra thus:

"I place the scene of four years ago before my mental vision and contrast the past and present. The result is one of the deepest disappointment. Four years ago I sat noting the face of a huge hill, cut in terraces—huge terraces, like a staircases for a giant. Then I looked upon the floor of the cut, and the lines of metals, engines and dumping cars. I regret to say that the cut, four years later, is almost the same. If its floor is 12 ft. lower, it will be a generouse stimate. Within the cut there seem to be about the same lines, perhaps a few additional ones. The hill that presented the pretty terraces, with sand papered banks—that was what they looked like, such was the mathematical evenness of their surfaces and equality of slopes—the former picture shows the same hill, with its sides weathered and terraceless, but the old and pretty lines have disappeared. These things had to be *beau*, utility being a secondary matter."

An excellent letter of over two columns follows, giving a very dark picture of the status of the work substantially in accordance with all later reports.

THE waste of material on the Panama work is then commented on at length, with numerous details, among which are the following:

"I have referred to the shameful way in which valuable plant is used. Now to cite a fact, to point a moral and adorn an 'o'er true tale.' Quite recently a new 4,000 kilo. grue, or moveable crane, went off the line near the Culebra cut. They cost $2,500 each. Down the slight embankment it went. The intelligent foremen of that section, instead of making any effort to recover it, simply buried it by ordering in a train of dumping cars. The crane was buried and remains buried. Its burial simplified the whole matter. It was not his, and the company had dozens idle. Words fail to convey any idea of how machinery has been used there. An engineer told me that three-fourths of the $30,000,000 worth of machinery on the Isthmus is rusting and much of it is useless, valueless even as old metal, owing to its location. The Canal company takes credit for $30,000,000 worth of machinery on the isthmus."

THE Prussian Government has recently appropriated $5,400,000 for improving a stretch of 80 miles of the river Oder, extending from Breslau to Kosel in Silesia; $800,000 for improving the bed of the river Spree, within the city of Berlin, $400,000 for improving the channel of the lower Oder and $1,800,000 for regulating sections of the lower Vistula. These river improvements are in charge of the Prussian Department of the Interior and the work is done by a special bureau.

THE report of the Committee of the American Society of Civil Engineers on grades and titles of engineers, as reported elsewhere, is that the titles should be in order of precedence, Chief Engineer, Assistant Chief Engineer, Division Engineer, Resident Engineer (in charge of work) and Assistant Engineer (not in charge of work), being substantially in accordance with the conclusions expressed in this journal Jan. 21, 1888. It is to be hoped that engineers generally will accept and act on this report, especially as respects the titles Division and Resident Engineer and so end the great confusion of practice which now exists, and which has resulted only from an English practice which has no parallel in this country; that of having an "Engineer" in London, who rarely went near the work, represented on the ground by a "Resident Engineer" who was practically in entire charge, the "Engineer" acting chiefly in a consulting capacity. The term "Division Engineer" is naturally a higher title than that of "Resident", and recent practice is more and more generally in that direction, even without formal recommendations. It should now become universally so.

THE recommendation of the title "Chief Assistant Engineer", instead of the more common "Principal Assistant Engineer", is also in the direction of common sense and more fairly descriptive of the office; and the limitation of the title "Assistant Engineer" to those who are not in responsible charge of any kind of work is also one which ought to be generally respected. "Assistant Engineer" means anything or nothing. It is often applied to very responsible positions, but still oftener to positions of no responsibility whatever, so that it is in no sense a definition. It is of more importance than appears to avoid such indefiniteness as much as may be, since enough of it must remain at best.

THE committee call attention to and condemn another evil, on which we commented, but one which it is difficult to see how to check effectively and properly, the indiscriminate assumption of the term "Consulting Engineer" by men of little experience and established reputation. Every one will agree abstractly that it is a title which should not as a rule be assumed by men of less than 40 years of age or 20 years experience, who have had for several years positions of great responsibility, and who may reasonably be expected to give advice of greater value in their special branch than that of the ordinary Chief Engineer. Yet who would question that ALEXANDER H. HOLLEY, for example, who died at the age of 35 was fully entitled to style himself a Consulting Engineer for several years before his death? The difficulty as to this title is even greater in mechanical than in "civil" engineering, for the reason that it is still harder to say just what and how much experience should qualify a man to be regarded as a "consulting engineer".

Engineering is becoming so vast a field that it is certain that the consulting engineer will become a larger and larger factor of professional practice, and it is for the interest of the profession in every way that it should be so. It is also a conveniently descriptive title, which can hardly be dispensed with without injury. It is a pity, therefore, that something cannot be done to formalize, in an unofficial way, the degree of experience warranting the use of the title, which must be done by the National Engineering Societies, if by anyone. It is rather a delicate question to meddle with, however, and we fear it will be severely let alone until the necessity becomes more pressing than now, as it will in time.

THE most serious railway accident of the week was the wrecking of a train on the Virginia Midland Railroad, July 12, by the giving way of a trestle near Orange, Va. The trestle was 48 ft. high and was being filled in, as it is said to have been weak. The train was moving at about 6 miles an hour, and the engine had got nearly across when the baggage, mail and express cars broke through the trestle and pulled the engine and two passenger cars down on top. The rear sleepers remained on the trestle, the couplings giving away. Five persons were killed and others injured. It is said that one of the passenger cars in the middle of the train was derailed on the trestle and caused the wreck. There are too many weak trestles now in service, and accidents similar to the above will continue to happen unless railroad officials take warning in time and strengthen these dangerous structures or replace them with new ones.

THE railway bridge across the Ste. Marie river at Sault Ste. Marie, Mich., is well provided with guard rails. Outside the track rails, with a clear space of 8 ins. between, is a 6 × 9 timber, laid flat, guarded with an angle-iron and boxed out 1 in. for the ties. Along the ends of the ties is a 10x10 timber, also boxed out 1 in. This timber ends at the bridge entrance, but the other guard rail flares out on the abutments.

THE awkward yard arrangements at the Grand Central Station in this city by which incoming and outgoing trains crossed each other in front of the station has been changed this week. Now the switching transfer will be made at 150th St. thereby saving several minutes in running time and rendering the making up of trains easier and safer. The Central trains will run on the left hand track without interruption to Spuyten Duyvil and come in on the right hand track. Harlem trains will use the left hand track going North as far as White Plains, but the New Haven trains will cross from the left hand to the right hand track when they reach Woodlawn Junction. The change in system was made on Sunday without accident. It was an unfortunate error of judgment that the station was ever arranged as it was, merely to bring the waiting rooms on the west side of the building.

THE demoralization in railroad rates reported last week still continues. The rates on dressed beef from Chicago to New York which were 65 cts. per 100 lbs. before the rate cutting commenced, have now gone down as low as 9 cts. at which figure of course, profits to the railways are out of the question. Rates on live stock are pulled down proportionately and a very large number of other articles are about as badly demoralized as the meat trade. The "Soo" line was disappointed in its attempt to obtain an entrance to New York over the New York Ontario & Western, hence its traffic goes *via* the Canada Atlantic & Central Vermont and they agree to deliver goods in St. Paul within 10 days of their receipt at New York.

In the West, the Chicago, Burlington & Northern has again published a lowered schedule; but Colorado rates, which have been demoralized ever since the opening of the new Panhandle route, have stiffened, an advanced schedule having been agreed on by all parties for the term of 30 days.

The hearing in the case of the Iowa railroads *vs.* the State rate fixing commission has been concluded, and Judge BREWER has reserved his decision. The Illinois Central has raised its schedule in Mississippi above that prescribed by the State Railway Commission and will defend its action in the courts.

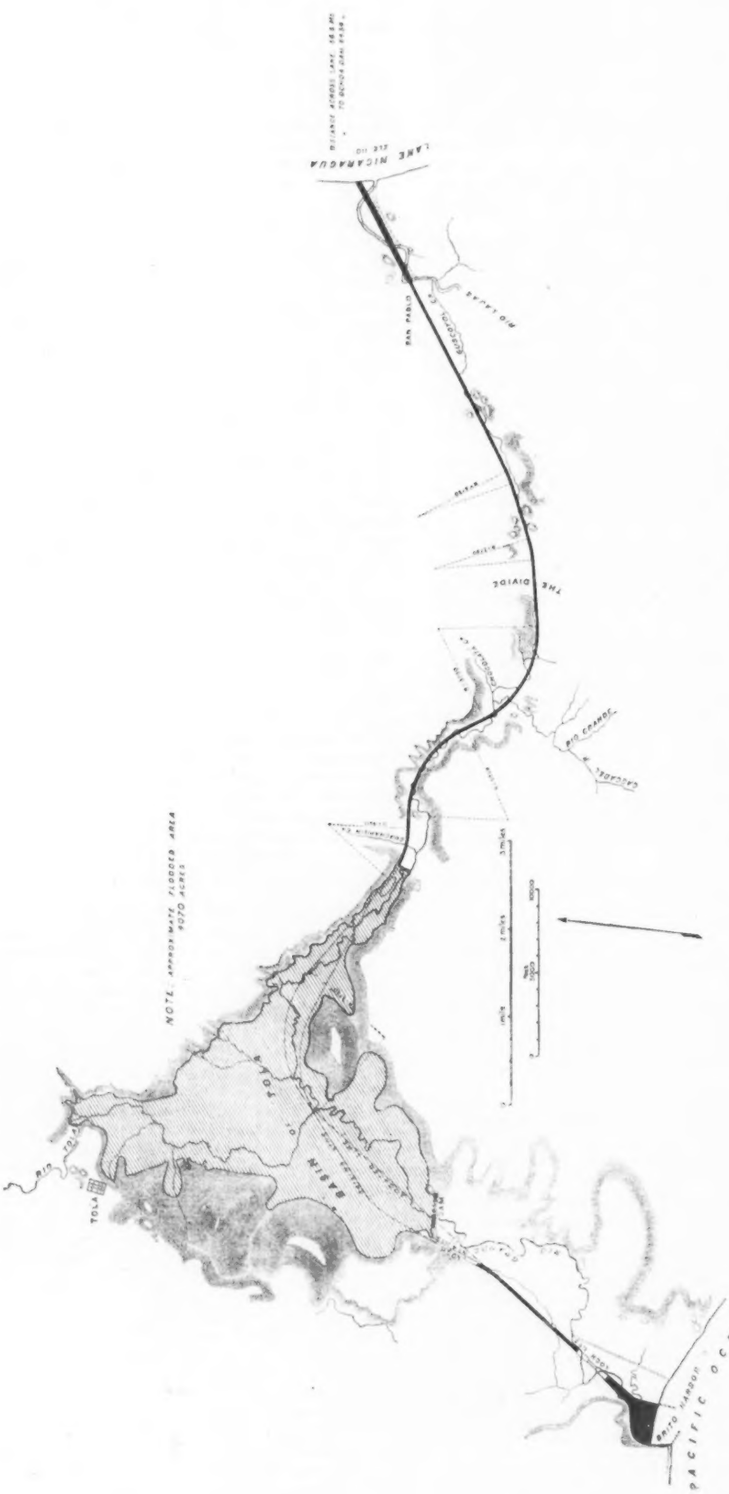
THE strike of the locomotive engineers on the Chicago, Burlington & Quincy system last spring has been unpleasantly brought to mind the past week by the exposure of an organized plot to blow up with dynamite, buildings and bridges belonging to the company. Great credit is due to General Manager STONE for his vigilance and alertness in thwarting this dastardly enterprise. It is also charged, and the charge seems to be well sustained by facts, that prominent officers of the brotherhood have been concerned in a scheme to injure the company's locomotives. A secret circular was sent out, requesting brotherhood engineers in remote sections to obtain employment on the Burlington system and by a judicious use of emery on the machinery and of sal-soda on the inside of the boiler to render the engines unserviceable. Such mean and despicable tricks must excite the indignation of every right minded man, and if the locomotive engineers' brotherhood does not severely reprehend this sort of work on the part of its members, it must fall still farther in the public estimation.

THE Inter-State Deep Water Convention held at Ft Worth, Tex., on July 11, had for its object the furtherance of the project for securing a deep water port at some point on the coast of Texas. The resolutions adopted ask Congress to provide for the appointment of a board of engineers to decide upon the most suitable port, which the Government will be asked to concentrate its work upon. A permanent organization was effected with Gen. R. A. CAMERON, of Colorado President; A. W. OLIVER, of Kansas, and J. T. CORNFORTH, of Colorado, Vice-Presidents, and T. J. HURLEY, Secretary.

THE Board of Engineers detailed to pass upon the plans and select the site for the Memphis bridge, were unanimous in the opinion that the bridge should be at least 75 ft. above high water. In regard to the length of span there was, however, a difference, of opinion, the majority favoring a span of 1,000 ft., while the minority considered 700 ft. a sufficient length. It is reported that the Secretary of War will take no action in the matter until the committee appointed to investigate the requirements of the bridge at Natchez have made their report. If this committee decide that a span of 700 ft. is enough for the Natchez bridge it is highly probable that the minority report in favor of a 700 ft. span at Memphis will be accepted.

THE work of constructing the projected railway bridge across the St. Lawrence, connecting Coteau with Valleyfield, has been commenced. The entire structure will probably be completed in a year, and will cost about $1,000,000.

BILLS to authorize the construction of the Hudson river suspension bridge have been introduced in both houses of Congress (the introduction in one house was noted last week) and a hearing has been ordered as to the possible injury to navigation. As there is no interference whatever with the river, which is passed by a single span of 2,830 ft., there is not likely to be any serious objection on that score. The estimated cost of the work complete has been much understated by a paragraph which is floating around in the newspapers at $16,000,000. That sum refers only to the bridge proper. The estimated cost of bridge and approaches is $37,000,000, $12,000,000 of which is for real estate. The probable traffic is much over-estimated, for some years to come at least, at 200,000,000, which is as many as the elevated railways carry; but it may reach 50,000,000, which at 5 cts. (instead of 2 cts.) toll would yield $2,500,000.



Nicaragua Canal: Location of 1888. Map No. 1. Western Division.
Lake Nicaragua to the Pacific Ocean, 17.27 Miles.

[The changes in this location from the location of 1885 are chiefly the substitution of the large Tola basin for an equal length of canal in excavation at a lower level, and the substitution of three locks for four locks.]

Nicaragua Canal Survey: Location of 1888.

We present herewith in the accompanying maps the final results of the Nicaragua canal survey which has been in progress since December last, and which were received about two weeks since from Nicaragua. The main results of the survey were summarized in our issue of June 30, and show decided improvements in several respects over the survey of 1885, which was, with slight changes only, over the same route. By far the most important change is the increase in length of slack-water navigation, and corresponding decrease in the length of canal in excavation, obtained by the substitution of additional basins created by dams at each end, as shown in the comparative summary below. As now presented, the route is certainly one of the greatest merit and interest, better in every essential respect than the Panama, even as it now stands after nearly eight years of work on it, and we see no room for doubt that it can be completed at very moderate cost; far less than either the cost of the Panama canal to date, or the cost of completing it as it now stands.

The profiles have not yet been received, nor the final contoured maps. Those we present are reduced from the smaller scale general maps ($\frac{1}{20000}$ or 1667 ft. per inch) but these are on a large enough scale to show with considerable precision all the main features of the work. As the route is in all parts substantially identical with the survey of 1885, of which an exact profile was obtained, we reproduce herewith that profile, showing by dotted lines the effect of the late revisions, as noted beneath it. The estimates for the revised route have not been made up yet, nor have precise reports of the borings been received. We give the aggregate of the estimates of 1885 in another column but postpone all detailed discussion of that side of the problem, until all results of the survey are received. The aggregate of work is beyond question materially less on this latest location, the main features of which may be summarized as follows:

Comparative Lengths in Miles.

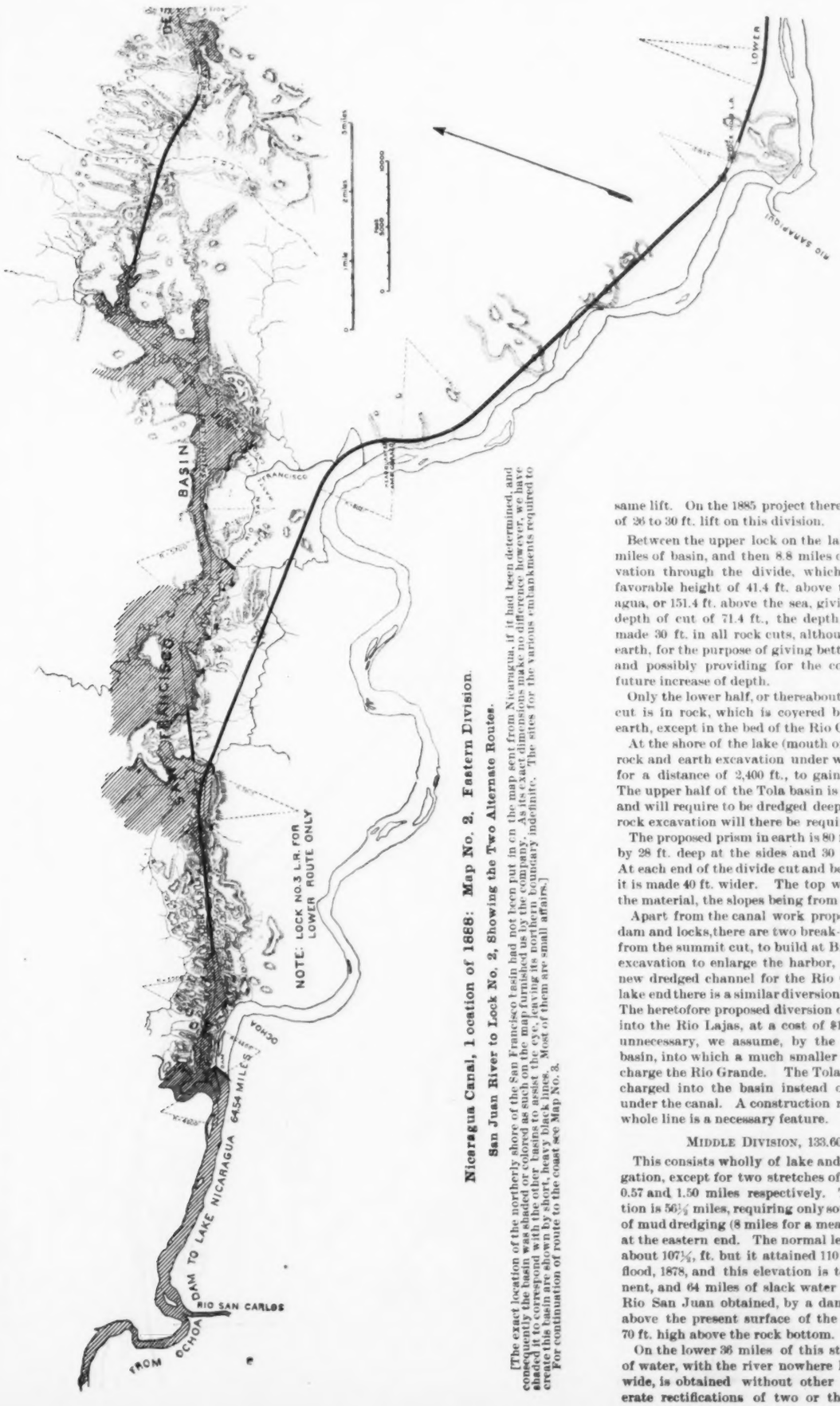
	Survey of 1885.			Survey of 1888.		
	Canal.	Free Nav.	Tot.	Canal.	Free Nav.	Tot.
Western Division,	17.27	00	17.27	12.14	4.83	16.97
Lake Nicaragua,	00	56.50	56.50	00	56.50	56.50
San Juan river,	00	64.54	64.54	00	64.54	64.54
San Francisco basin	3.00	9.01	12.01	1.50 0.57	1.45 9.04	12.56
Great Divide Cut,	3.00	00	3.00	3.03	00	3.03
Divide Cut to Greytown,	16.48	00	16.48	12.95	3.40	16.35
Total,	39.75	130.05	169.80	30.19	139.76	169.95

WESTERN DIVISION, 17.27 MILES.

This division has by far the most favorable climate and other conditions for easy construction. The main features are, as reported, a stretch of earth dredging of about 1⅛ miles to lock No. 5 (formerly lock No. 7) with a lift of about 35 ft.; another stretch of earth excavation or dredging of about 2 miles to locks No. 3 and 4, which come together at the site of former lock 6 and then the Rio Grande or Tola slack water basin, which is at the summit level, and formed by a dam, as shown, only 3.34 miles from the coast. The dam is about 71 ft. high and 1,200 ft. on the crest.

The borings show only clay, sand and gravel on this part of the route, including the foundations of all the locks. It is proposed to use timber and concrete foundations for them, and to build the walls likewise of concrete, with timber lining in the chambers and bags. The dimensions proposed are 650 ft. long by 65 ft. wide in the clear and 28 ft. deep The chamber width of the locks will be 80 ft. The Sault Ste. Marie lock, the largest in the world, is 515 × 80 × 16 ft.

The project is under consideration of substituting only two locks for three on this division, to correspond with the project for the Eastern Division. Should the construction of locks of such great lift seem inexpedient, however, except when excavated out of solid rock, three locks will be used on each side. Whether two or three locks be used on the Western Division affects, plainly, only the location of the short middle level and, to some extent, that of the locks themselves. The great difficulty is to ensure tightness under the increased head of water. Otherwise, the total material required for two locks of 110 ft. total lift, is less than for three with the



Nicaragua Canal, Location of 1888: Map No. 2. Eastern Division.

San Juan River to Lock No. 2, Showing the Two Alternate Routes.

[The exact location of the northerly shore of the San Francisco basin had not been put in on the map sent from Nicaragua, if it had been determined, and consequently the basin was shaded or colored as such on the map furnished us by the company. As its exact dimensions make no difference however, we have shaded it to correspond with the other basins to assist the eye, leaving its northern boundary indefinite. The sites for the various embankments required to create this basin are shown by short, heavy black lines. Most of them are small affairs.]

For continuation of route to the coast see Map No. 3.

same lift. On the 1885 project there were four locks of 26 to 30 ft. lift on this division.

Between the upper lock on the lake there are 4.83 miles of basin, and then 8.8 miles of canal in excavation through the divide, which is at the very favorable height of 41.4 ft. above the Lake Nicaragua, or 151.4 ft. above the sea, giving a maximum depth of cut of 71.4 ft., the depth of water being made 30 ft. in all rock cuts, although only 28 ft. in earth, for the purpose of giving better steerage way, and possibly providing for the contingency of a future increase of depth.

Only the lower half, or thereabouts, of the summit cut is in rock, which is covered by 20 to 40 ft. of earth, except in the bed of the Rio Grande.

At the shore of the lake (mouth of the Rio Lajas,) rock and earth excavation under water is required for a distance of 2,400 ft., to gain 28 ft. of depth, The upper half of the Tola basin is also too shallow, and will require to be dredged deeper. Little or no rock excavation will there be required.

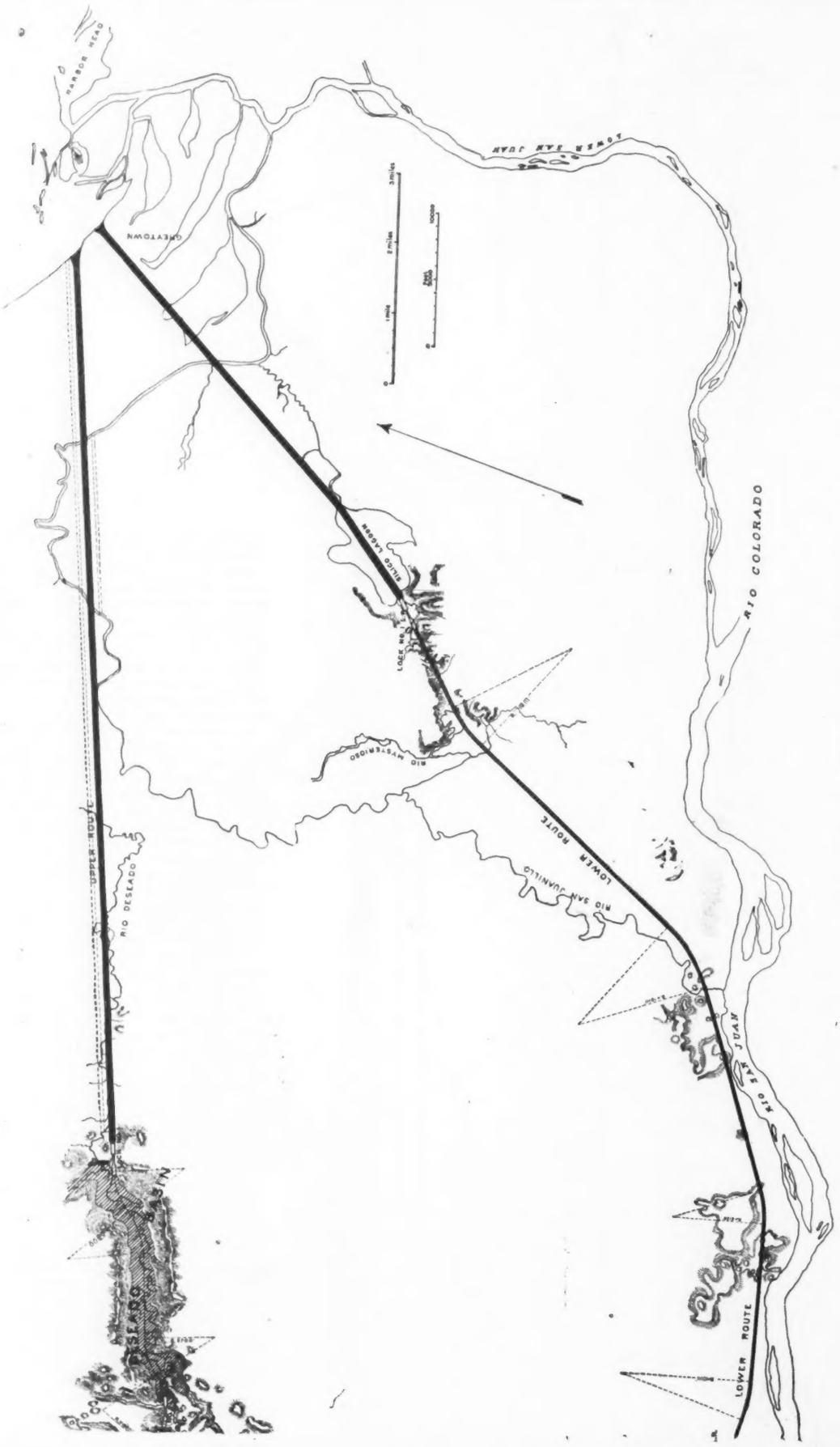
The proposed prism in earth is 80 ft. bottom width, by 28 ft. deep at the sides and 30 ft. in the center. At each end of the divide cut and below the last lock it is made 40 ft. wider. The top width varies with the material, the slopes being from 3 to 1 up.

Apart from the canal work proper, including the dam and locks, there are two break-waters of rip-rap from the summit cut, to build at Brito, considerable excavation to enlarge the harbor, as shown, and a new dredged channel for the Rio Grande. At the lake end there is a similar diversion of the Rio Lajas. The heretofore proposed diversion of the Rio Grande into the Rio Lajas, at a cost of $1,400,000, becomes unnecessary, we assume, by the creation of the basin, into which a much smaller expense will discharge the Rio Grande. The Tola river is also discharged into the basin instead of being carried under the canal. A construction railway along the whole line is a necessary feature.

MIDDLE DIVISION, 133.60 MILES.

This consists wholly of lake and slackwater navigation, except for two stretches of canal in earth of 0.57 and 1.50 miles respectively. The lake navigation is 56¼ miles, requiring only some 900,000 cu. yds. of mud dredging (8 miles for a mean depth of 3½ ft.) at the eastern end. The normal level of the lake is about 107½, ft. but it attained 110 ft. in at least one flood, 1878, and this elevation is to be made permanent, and 64 miles of slack water navigation in the Rio San Juan obtained, by a dam at Ochoa, 52 ft. above the present surface of the water, or some 70 ft. high above the rock bottom.

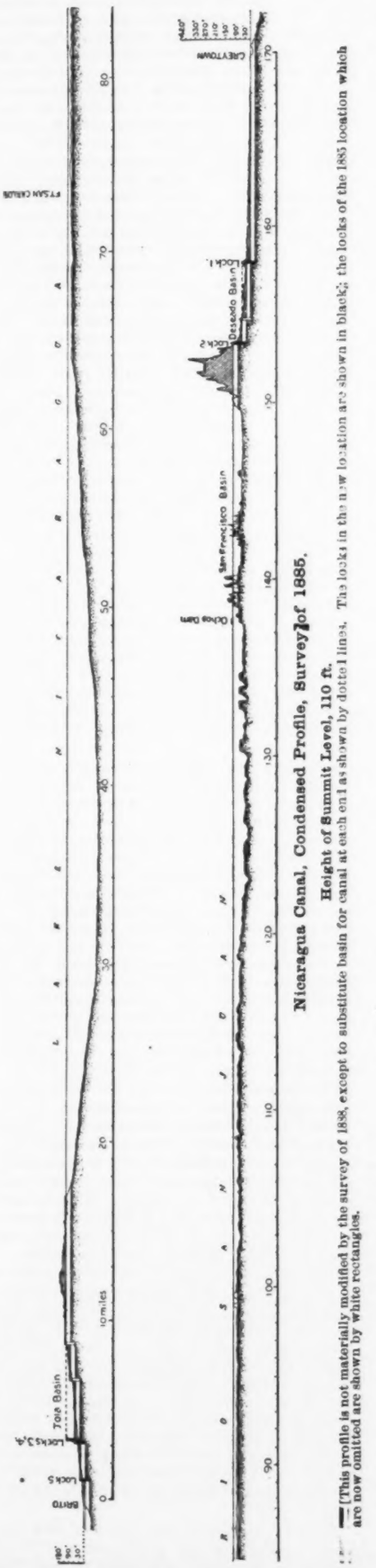
On the lower 36 miles of this stretch, 26 to 130 ft. of water, with the river nowhere less than 1,000 ft. wide, is obtained without other work, than moderate rectifications of two or three sharp bends.

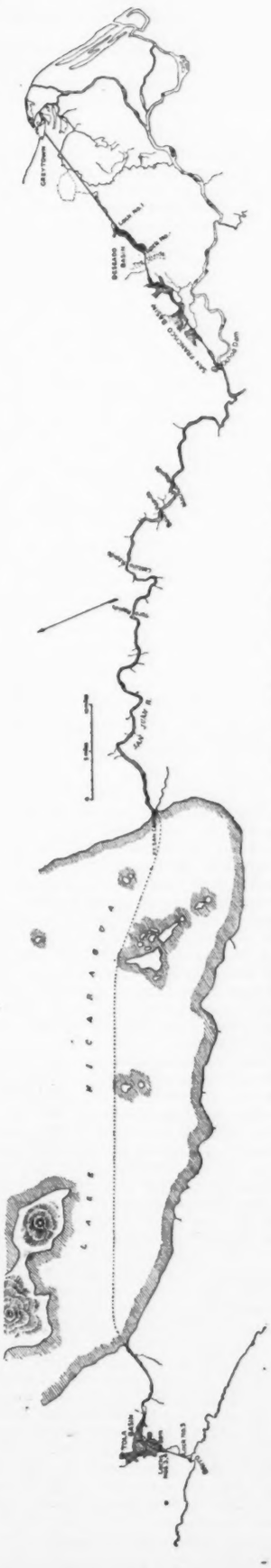


Nicaragua Canal. Map No. 3. Eastern Division.

Lock No. 2 and Desendo Basin to Greytown.

[The direct or upper route is the one most likely to be chosen, as noted elsewhere. Side diversions of river channels are required on both sides of the canal, as shown by dotted lines. They are required on the lower route also, but are not shown.]


Nicaragua Canal, Condensed Profile, Survey of 1885.
Height of Summit Level, 110 ft.
[This profile is not materially modified by the survey of 1888, except to substitute basin for canal at each end as shown by dotted lines. The locks in the new location are shown in black; the locks of the 1885 location which are now omitted are shown by white rectangles.
Toro Basin
Ochoa Basin
San Francisco Basin
Dolores Basin
Lock 1
Lock 2
Lock 3
Lock 4
Lock 5
Lock 6
Dolores Dam
Ochoa Dam
10 miles


Nicaragua Canal, General Map of the Entire Route from Ocean to Ocean.
[We have reproduced this map from that accompanying the Report on the Survey of 1885, with the addition of the basins, etc., as nearly as might be, but the map is not expected to be precisely accurate.]
LAKE NICARAGUA
SAN JUAN R.
GREYTOWN
Dolores Basin
San Francisco Basin
Ochoa Basin
Toro Basin
Lock 1
Lock 2
Lock 3
Lock 4
Lock 5
Lock 6

The Toro rapids occur 28 miles from the lake, and here, and at one or two other points rock excavation under water will be necessary to an aggregate amount of 398,613 cu. yds. by the 1885 estimates. Above the rapids there is some 2,000,000 cu. yds. of earth dredging only to obtain the necessary depth.

Below Ochoa, the San Juan river becomes entirely impracticable for slack-water purposes. The banks are very flat, and no suitable site for a dam exists. Here begins one of the most admirable features of the 1885 and 1888 location; the creation of basins out of the lateral tributaries, by which, with only two small bits of canal in excavation to connect the basins, slackwater navigation is extended to the great divide cut, 12.56 miles further. How this is done is sufficiently apparent from the map, without description. The main basin is that of the Rio San Francisco, which is dammed by an embankment, as are also various minor streams and hollows in the divide, at twelve different points in all, as shown on the map, where the height of the false divide between the San Juan and its tributary is not up to the requisite level of about 106 ft. above the sea (4 ft., or ¾ in. per mile, being allowed for the fall of the river from the lake.)

The two short bits of canal being dredgable, there is practically nothing to do on this long division of 133.6 miles but to build the dam and embankments, and dredge them through to obtain navigation at once for light draft vessels. Most or all dredging and rock excavation near the lake, as also all rectifications of channel (none of which are absolutely essential) may be postponed if desired until after the canal is so opened, or certainly until after the dams and embankments are constructed. Since the earth can be dredged as well after flooding as before, while most of the rock is at points where the depth of water is not greatly increased, and where the advantage of having still water in place of a rapid current would more than compensate for the greater depth, if the company are wise they will, in our judgment, postpone all postponable work under water of this nature until the canal is opened for light draft vessels, even at some increase of cost.

It has been heretofore intended, and is still, to build the dams of concrete and the embankments of puddle and earth. We believe this is unnecessary and inexpedient. Such works require a good deal of skilled and faithful labor, will be necessarily costly under the Nicaragua conditions, and will not be entirely trustworthy after their completion. The water supply being eight or ten times what is needed the tightness of the dams is not essential. Much better and vastly cheaper work, in our opinion, can be obtained by making all the dams and embankments plain rock fills, aided to seal themselves by deposits of earth. Such dams, in fact, will seal themselves almost absolutely tight if properly aided by nature or art, but their advantages are most conspicuous where simplicity of construction is important and tightness unimportant.

Abundant rock spoil for this purpose at the cost of hauling and dumping exists near the site of all the dams; and this being so, the prominent part which dams play in the revised location is in our judgment one of its most favorable features. We shall discuss the conditions under which such dams may be advantageously used, and their proper construction, at a later date; but in the meantime note only that the $6,000,000 to $8,000,000 which these dams will represent in the estimates (and which, to say the least, would be none too much) would be two or three times more than rock fill dams of the most solid construction need cost, thus compensating for any items under-estimated, as some of them seem to be, notably the clearing, at $100 per acre, and the construction railway at $16,000 per mile.

The whole region of Nicaragua, east of the lakes through which the canal passes, is densely wooded, covered with tropical vegetation, subject to a heavy rainfall, and almost uninhabited. The banks of the San Juan river are almost everywhere low and swampy. It is therefore most fortunate that very little disturbance of the soil will be necessary except by dredging; and that, except as the natural tendency to malarial troubles in such a region might be stimulated by such disturbance of the soil, as it doubtless would be, the region is not unhealthy, nor hotter than our ordinary summer weather, a stiff breeze from the trade winds blowing up the river almost constantly.

EASTERN DIVISION, 19.38 MILES.

The Eastern Division begins with the backbone of the whole work, the great divide rock cut, 3.03 miles long; the highest point being 396 ft. above sea or 310 ft. cut, one mile averaging 210 ft. cut, and the entire length of 3 miles averaging about 149 ft., containing an aggregate of 7,760,000 cu. yds. of rock, capped by 771,800 cu. yds. of earth, the total estimated cost at $1.50 for rock, 40 cts. for earth and $100 per acre for clearing, being $11,983,000. It is stated that sufficient head of water exists to excavate most of the earth hydraulically. Higher ground exists on each side for the location of camps, exposed to the direct access of the trade winds over the 18 miles of intervening coast flats, and in the absence of any epidemic diseases the claim seems reasonable that the work on this cut, on which a large force will necessarily be employed, will be healthy. It will naturally be the first work started, as the time necessary to complete it is the limit for the whole work. A very important factor, however, is the fact that a large part of the cut (how large cannot be stated till the full results of the borings are worked out) consists of *tepetate*, a strange volcanic ash material abounding from Mexico southward, wholly unknown here, which takes a slope like rock and is not much more difficult than earth to work, especially in large masses.

The great cut terminates on the east in lock No. 2 (formerly No. 3) 53 ft. lift, excavated out of the solid rock and faced with concrete, which lowers the canal to the Deseado basin, another new feature of this survey, 3.40 miles long, in substitution for an equal amount of canal in excavation. The possibility of forming this basin, as also the Tola basin, was considered in the 1885 survey, and suggested, but not determined.

The upper end of this basin will require some earth and rock excavation to obtain the required depth of channel. The earth, we should imagine, would be excavated by dredges, and the water then drawn off and the rock excavated. Lock No. 1, also of 53 ft. lift, (which takes the the place of two heretofore proposed, and may be again divided into two should it seem desirable) lowers the canal down to the sea-level channel dredged in from Greytown, some 12 miles, all of it shown by the borings to be through earth. After the eminent success of this part of the Panama work under decidedly worse conditions as to health and certainly no better as to rainfall, this part of the canal need cause no anxiety, nor need its probable cost in time and money be allowed much limits of doubt. Side channels for the San Juanillo and Deseado rivers are required parallel with the canal, as shown by dotted lines, which are likely to be also dredged.

THE HARBOR OF GREYTOWN.

Greytown had formerly a very good harbor which has been gradually filling up with sand, brought in by the strong littoral current, until now there is practically no harbor left. It is claimed that by building out a breakwater this current can be diverted, and that then an excavated channel through the bar will not fill up. It is quite possible that more work may be required here than is expected, but it is obvious that the creation of a suitable harbor is possible here at no extravagant cost, and that it may, if necessary, be postponed until after the completion of the canal proper, after obtaining sufficient depth of water for construction purposes. Money will be then easy to obtain for such a purpose, if more than is expected is found necessary.

THE LOWER ROUTE.

A final choice between the route described and the "lower route," following the San Juan river, as shown on the map, has not yet been made. We have described the "upper route" only, however, since it seems clear that it is decidedly preferable to the lower route. The objection to the upper route is the heavy rock cut above described, which is certainly a work of great magnitude (about 8,000,000 cu. yds. of rock at $1.50 per yd. are allowed for in the estimates) but one simple in its nature, and the work on which may be so organized as to ensure rapid progress with a comparatively small force of employés by the aid of modern explosives, rock drills and other plant. If a large fraction of the cut proves to be *tepetate*, the total separate cost will be still further reduced. On the other hand the objections to the lower route are:

1. It is 6.42 miles longer, (176.37 miles instead of 169.95) not a serious objection in itself, since the same traffic at the same tolls would probably be obtained by either route.
2. The canal in excavation is 18.86 miles more, or 49.05 miles in place of 30.19, (all the excess being in the unhealthy east coast flats) seriously increasing the inconveniences of both construction and navigation.
3. Four locks are required instead of two.
4. A larger force will be required, who will work under conditions less favorable to health.
5. The allowance for contingencies and uncertainties, both in construction and maintenance, must necessarily be much greater.

Did not a better route exist, this would be a good one, for the work on it is adjustable to the ground by the locks, and hence cannot be very heavy. On the old project of 1872-3, which followed this route, there were 10 locks and 4 dams of the San Juan, with 10 more locks on the western slope. In this shape the project came before the LESSEPS International Canal Congress of 1879. Had even the lower route, not to speak of the upper, been presented as we now present it, we have no doubt that even DE LESSEPS' obstinate prejudice in favor of a sea-level canal would have given way, and that the Nicaragua canal would now be open to the world.

From all the information at our command, the prospect seems strong that work on the Nicaragua canal will begin very soon, that the necessary funds will be obtained, and that the work will be pushed through to completion in about five years after work is fairly under way. Should the Panama Canal Co. go to pieces, as now seems probable, this result will be more sure, but even if the work on that Canal be persisted in, it is so much the longer route for most of the traffic, has so many more locks and is in such a region of calms, that the Nicaragua canal would get the lion's share of the traffic if both were open.

The Manufacture of Dynamo Machines and Electric Lighting Apparatus.

(*Concluded from page 8.*)

The Incandescent Lamp Department forms a large and almost distinct business in itself, and is located on the third floor of factory B. On this floor 120 girls and women are employed; and they are found better adapted to the work of handling the delicate carbon filaments than men or boys. The bamboo strips from which the filaments are made are first cut by hand, and then reduced in diameter to about $\frac{5}{1000}$ of an inch by being drawn through a series of six dies of successively smaller sizes. They are then dampened and baked. In the next process they are put in clamps and placed in jars containing a hydrocarbon vapor, and a current passed through the filaments.

By this means carbon is deposited on the filaments, and the resistance is thereby reduced. Each girl has a mirror galvanometer and scale by which the resistance is tested, and the process is continued until the point required is reached. In this process, too, the filament gets a twist like the Fig. 8, which is peculiar to the THOMSON-HOUSTON incandescent lamps and has the advantage of giving out an equal amount of light in every direction. The filaments are next mounted on platinum stems, and the junction is improved by depositing carbon at the joint by the electric current, making the joint perfect. The filaments are then passed to the glass blowers department where 25 to 30 men are employed. The globes are purchased ready blown, and are tubulated by the insertion of a tube at the bulb end, through which the air is finally exhausted. The filaments are then sealed into the bottom or mouth of the globe. Globes for the series lamps, run in connection with arc lamps on the same circuit, are also made, and are so arranged that if a lamp breaks, the circuit for the other lamps still remains intact.

In an adjoining room are manufactured the stems and improved vacuum pumps used by the company. A set of 20 power vacuum pumps are used for exhausting the air from the jars in the incandescent lamp manufacture. Copper and platinum wires are soldered together by a fixed soldering tool fastened over a lamp.

Beyond the incandescent lamp stock room is a room entirely occupied by the mercury pumps used for exhausting the air from the lamps. The number of these is 400, and they have a capacity of exhausting 1,500 lamps per day. The air is exhausted to its limits by means of falling drops or streams of mercury which carry minute quantities of air down with each drop. The process occupies about five hours, and near the close the lamp globes are warmed to expand and drive out the remnants of the air The amount of mercury used is 7,750 lbs., equal in value to over $5,000.

The incandescent lamp testing room is on the third floor of factory A, and has a capacity of testing 1,000 lamps at a time, besides 100 series lamps. Every lamp is given two tests. After the first test the brass collar is put on with a preparation of plaster of Paris and whiting, after which the second test is made. The average duration of the tests is about 7 hours. The series lamps have three tests. The brilliancy of this room is scarcely excelled by that of the arc light testing room below. After testing, the lamps are washed, and those with imperfectly shaped loops are either destroyed or used for shop lighting. The capacity of the lamps is from 16 candle power upwards, and a life of over 600 hours burning is guaranteed. The next department is the special machine testing room, where new motors are tried and mechanical measurements made. There is here a fine 2½ H. P. motor running at a high velocity, the current being brought by wire from the lower floor; also a sample 15 H. P. motor for street railway use, similar to those in use at Woonsocket, Allegheny City, etc. This motor is noiseless in its action, is perfectly balanced and works without appreciable wear. Raw hide is used for one of the gears, and works with the other gears, which are steel faced. A peculiarity of the brush is that it is mounted on bearing slides on a stud of the yoke, with movable holders, so that it can be moved over the surface of the commutator, distributing the wear over different portions. The speed of armature is about 1,200 revolutions per minute, and the gears on the motor reduce 4 to 1. One further reduction by a pair of gears brings it to the speed required on the car axle.

Adjoining is the general instrument room, where all fine measurements are made. Connection is made from here with the different winding and arc testing departments. Some of the instruments employed here are a Sir William Thomson potential and current indicator, a fine Wheatstone bridge, accurate to one-tenth of one per cent., a Carpentier reflecting galvanometer, Siemens electro-dynamometer, Sir William Thomson's electro-static voltmeter and a Carden voltmeter. There is also an apparatus, invented by Prof. THOMSON, for testing the electrical and magnetic qualities of iron, which is used on samples of all supplies of this kind. There is the standard legal ohm, a tangent galvanometer, an Ayrton & Perry ohmmeter and ammeters. A fine barometer with vernier is used in connection with the incandescent lamp manufacture for comparing the degree of vacuum reached, and there is a set of balances, sensitive to $\frac{1}{10}$th of a milligram.

Opening from this is the photometer room, containing a fine Bunson photometer, for measurements of the intensity of light and comparisons.

Beyond is an experimental room devoted to incandescent lamp development. On the roof is a large search light which can throw a light so powerful that papers can be read at night seven miles distant and the light of which can be seen, when thrown vertically in the air, for twenty miles.

In the rear of factories *A* and *B* is the new boiler and engine house for factory *C*. This is of one story, brick, and contains two 125 H.P. boilers, which supply steam to a double Greene engine of 500 H. P., built by the Providence Steam Engine Co. The cylinders are each 20 in. diam. by 42 in. stroke. The fly-wheel weighs 18½ tons and is 20 ft. in diameter, with 38-in. face, carrying a 36-in. belt. The speed is 100 revolutions per minute, steam pressure 80 lbs.; and the cut-off is so arranged that it can be instantly used to stop the engine without shutting off steam at the main valve. The engine countershaft is situated on the second floor of factory *C*, which is in the rear of engine house.

The lower floor of factory *C*, is used as a heavy machine shop for the manufacture of electric motors for stationary and street railway work, and for turning and winding fields and armatures.

The central section is kept free from fixed machinery and is supplied with a traveling crane, its use being for setting up and testing. The side sections are occupied by heavy lathes, drills and punches, among which was noticed a Pond radial drill, with 6 ft. arm. The stairs and closets in this building are placed in towers, leaving the area of main floors unbroken. There are two lines of shafting on each floor, so arranged with friction clutches at intervals, that the use of a section can be discontinued, when necessary, without stopping the entire line. The second and third floors are devoted to the manufacture of the smaller parts of alternating dynamos, lightning arresters, motors and transformers. In the transformer testing department thousands of incandescent lamps are kept in racks fastened to the ceiling, and below in a compartment on the floor the transformers are kept, and are tested by the lights. A primary current with a potential of 1,000 volts on passing through the transformers is converted into one having a potential of fifty volts. The object is to employ a high potential current in the main line of an electric circuit, with a maximum economy in size of wire and of operation and by means of these instruments to take off a low potential current for use in incandescent or indoor lighting. Beyond factory C, is a large store-house, also a store-house for patterns, and a building devoted to the business now supposed to be in its infancy, of electric welding, which we have heretofore described.

Practical operation of lighting systems.—In connection with the manufacture of electric apparatus some figures as to extent and costs of lighting systems furnish information of interest. In New York 1,717 electric lights, the plant for which cost $181,000, have displaced the use of 56,000 gas lights. In Brooklyn, N. Y., 1,000 arc lights have been introduced at a cost of $100,000 and have displaced 125,000 gas lights. It is stated that when Brooklyn contained a population of but 400,000 the cost of lighting by gas was over $700,000 annually. With the electric light and a present population of 700,000 the cost is but $400,000.

The plant of the Citizens Electric Co. in Brooklyn includes a two-story brick building with basement, 100 × 75 ft. in size. Six 100 H. P. boilers are used in connection with two engines of 300 H. P. each, running 29 dynamos arranged in two rows, driven from a central shaft. Besides 1,000 arc lights, a number of series incandescent lights are operated and power furnished to motors running fans, light lathes, sewing machines, blowers for church organ bellows, pumps, elevators, etc. The force employed to operate the station, which has about fifty miles of wire out, consists of a superintendent, several office clerks and collectors, a store room clerk, 2 night and 2 day engineers, 2 firemen, a coal purser and 2 oilers in the dynamo room; and out of doors 3 linemen, 4 helpers, a driver and 12 lamp trimmers, which latter number is doubled during the winter months.

As to costs of introducing plants it is stated that for a small plant, with building of low cost, 4 dynamos and attachments, 5 to 10 miles of wire, two 60 H. P. engines and a 125 H. P. boiler can be built on capitalization of $25,000. A 225 arc light plant, with 5 dynamos, two 75 H. P. engines and two 125 H. P. boilers can be capitalized and built for $50,000, and it is estimated will pay from 15 to 20 per cent. on the investment. Or, for the same amount, a combination plant of 150 arc lights and 750 incandescent can be put in. A 60 arc light plant, with 2 dynamos, a 100 H. P. boiler and 60 H. P. engine costs $15,000; a 90 arc and 500 incandescent with 2 large arc dynamos, 2 medium sized incandescent dynamos, boilers and engines, costs $30,000; and a 105 arc light plant $25,000.

The Thomson-Houston Co. has supplied plants to more than three hundred local companies, nearly 50,000 of its arc lights being now in use in various parts of the world, and besides a list of localities in the United States too long to insert here, comprises plants in Honolulu, Hawaiian Islands; at the Royal Arsenal at Woolwich, England; Taunton, Somersetshire, England; Guatemala City, Colon and the Isthmus of Panama, Central America; Lima, Peru and several other South American cities; Naples and Milan, Italy; Wexio and Hernosand in the far north of Sweden; at Tammerfors, Finland and many other distant places. Yet this company is only one among several great American companies, some of which would dispute the claim that it is the largest of them all, while there are many large companies abroad. These facts will give some idea of what an immense interest the manufacture of electric plant has become, yet it is quite certainly only in its infancy.

The Theory of Earthquakes.

BY RUDOLF FALB.*

[Translated for ENGINEERING NEWS by F. G. LIPPERT].

What the terrible earthquake on Feb. 23, 1887, in the Riviera, accomplished, directing men's attention to the phenomena of earthquakes, is everywhere known. A hundred books could not have done this. All over Europe and far beyond her limits, the query as to the origin of the dread visitor has recently been much ventilated; a return to it here will hardly require an apology.

It may not be long before the same visitor will knock at the door again in other lands. As for the Riviera, the consolation remains that such catastrophes, as a long experience has shown, occur in the same region, but once in a space of about 50 years. The last discharge of an earthquake center in the vicinity of the Riviera, took place Oct. 9, 1828, when between Voghera and Genoa, in the valley of Stalfora, a terrific shock, which was felt as far as Marseilles, Genoa and Turin, caused immense destruction. This shock occurred at 3:11 A. M., and it is very significant that in the same night—precisely as during the earthquake of 1887—an annular eclipse of the sun took place which lasted from 10 P. M., until 4 A. M., the following morning.

The coincidence of eclipses with earthquakes has already been mentioned by ancient writers. ARISTOTLE, in his meteorology, says:

"Now and then it happens that about the time of a lunar eclipse an earthquake occurs" (II. 8) According to PHLEGON, of Tralles, a chronicler of the second century, there took place in the 202d Olympiad, a great solar eclipse accompanied by an earthquake by which the town of Nicaea, in Bithynia, was destroyed. In the same Olympiad falls also the earthquake and the eclipse observed at the death of JESUS CHRIST on the 3rd of April of the year 33 of our reckoning. On the evening of that day, which, as was first shown by the author, proves indeed to have been on Friday, and besides, the eve of the Passover of the Jews, the full moon rose over Jerusalem eclipsed. On Dec. 22, 968, B. C., a great earthquake occurred at Corfu during a total eclipse of the sun. On Dec. 14, 1797, the town of Cumaná, Venezuela, was destroyed by an earthquake four days prior to a solar eclipse, and precisely the same relation is to be noted between the destruction of Arequipa, Peru, and the subsequent eclipse of the sun. Still more strikingly, however, has this coincidence become apparent in recent times. On March 6, 1886, the town of Cosenza, Italy, and surroundings were visited by a destructive earthquake which was preceded, the night before, by the first one of the two eclipses of that year. On Aug. 29, of the same year the second eclipse occurred on each side of which we find symmetrically grouped the two great catastrophies of that year, viz.: the earthquake of Philiatra, Greece, on Aug. 27, and that of Charleston, S. C., on Aug. 31. In what a state of violent commotion the depths of the earth must have been at that time, can be judged by the circumstance that on the same day (Aug. 31) the volcano on the Island of Nina Feon, in the South Sea, after more than 30 years of quiet, had so powerful an eruption that all the villages surrounding it, two only excepted, were destroyed and covered 12 ft. deep, with volcanic débris. This event was followed by the eclipse and earthquake in the Riviera of Feb. 23, 1887, and later, on Aug. 2, of the same year, by the annihilation of the town of Cuenca, Ecuador, by an earthquake which preceded a lunar eclipse by one day. The cases cited are so striking that, considering the relative rarity of earthquakes on the one hand, and eclipses on the other, one can no longer, according to mathematical probability, assume their coincidence to be accidental, but must pronounce them to be in accordance with some natural law.

Assuming the existence of such a law, the question arises: What is the influence exerted by an eclipse upon the phenomenon we call an earthquake? To answer this question, we will be obliged to inquire into the primary causes of earthquakes. But as all causes assigned hitherto have been in the nature of mere subjective opinions, it will be necessary to reverse our question, thus: Which one of all possible causes of earthquakes is of such a character that its connection with eclipses becomes a physico-mathematical necessity? Proceeding in this manner, the investigation into the causes of earthquakes becomes essentially simplified. Moreover, when we include in our inquiry other facts brought to light in examining the statistics of earthquakes, as, for instance their distribution according to the different months of the year, their relation to the phases of the moon, etc., then the limits between which conjectures as to the most probable causes of earthquakes are permissible, become so narrowed down, that the final result of our inquiry can hardly be called an arbitrary or personal one.

We will first examine catastrophic shocks, as presenting in the most striking manner the phenomenon to be unriddled. Here we distinguish:

The mechanical character of the shock.

The continuation of shocks.

Their distribution as to locality, and their distribution as to time.

These four points, which all investigators acknowledge to be essential in searching for the causes of earthquakes, will now be treated successively.

The Mechanical Character of Shocks.—When information is received from different points of an extended area, of simultaneous earthquake shocks, we always find that one of the points shaken, received the severest shock, and that the other places which were shaken with lesser force, are grouped nearly symmetrically around the former. This point is called the *superficial centre* of the earthquake. Its location is nearest to the *subterranean centre* or *focus* from which the shock originated, and nearly vertically above the same, a fact proved by the vertical upheaving motion of the ground. Whatever the immediate cause of such a shock may be, its rays always run out from the focus in all directions like the radii of a sphere. This furnishes at once the characteristics of a shock for the different points in question. At the centre, where the radial blow strikes the surface at right angles, its effect should be a vertical rising motion of the ground, whilst the surrounding places are struck the more obliquely the farther they are removed from the centre, and the effect here will be a lateral, undulating motion of the ground. The force of a shock at the superficial centre, according to a fundamental law of mechanics, depends, on the one hand, upon the intensity of the shock at the focus; on the other hand, upon the distance of the latter from the surface of the earth. The extent of the area effected is likewise proportionate to the intensity of the original shock; and proportionate also to the vertical distance of the focus from the earth's surface. It may be said, therefore, that catastrophies affecting a small territory, generally originate at a lesser depth than those extending over a large area. To give the reader a cursory idea as to the depths from which this terrible phenomenon proceeds, we will here state the results of some computations believed to be approximately correct:

Origin of the Earthquake of:		*Depth in Miles:*
1. Basilicate	Dec. 16, 1857	7.5
2. Herzogenrath	Oct. 22, 1873	6.8
3. Central Germany	March 6, 1872	19.5
4. Sillein	January 15, 1858	16.2
5. On the Rhine	July 29, 1864	26.7

whilst the highest elevation reached by mountains upon the earth's surface, is but 5.6 miles.

The points to be borne in mind by the reader, are, first, that one center only is observed in any one catastrophe, and second, that the main shock is first felt to act in a vertical direction.

(TO BE CONTINUED.)

* Herr RUDOLF FALB, who has attracted general attention by his paper on the theory of earthquakes, which we here translate, was born April 13, 1838, in Obdach, Styria. He studied for the priesthood and officiated as a Catholic priest for two years, and then turned his attention to mathematics, physics and astronomy. In 1868, he founded the astronomical journal, *Sirius*, which he has ever since conducted. In 1870 appeared his *Principles of a Theory of Earthquakes and Volcanic Eruptions*. After a protracted stay at Vienna, for the purpose of studying geology at the *Polytechnikum*, Herr FALB set out for South America to investigate volcanic phenomena and, at the same time, to pursue archæological studies. As a result, he published his book: *The Land of the Incas, its Relations to the Primeval History of Language*, and another work: *The Language of the Andes*.

Herr FALB, who, some 15 years ago, became a Protestant, now resides at Leipzig. He has drawn public attention to the results of his learned researches, and made them popular, by lecturing in many of the more prominent cities of Europe.

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Coming Technical Meetings.

Engineers' Society of Western Pennsylvania, Pittsburg, Pa.—Regular meeting, July 17. Secy., S. M. Wickersham Penn Building.

New England Roadmasters' Association. — The 6th, annual meeting will be held at Boston, Mass., August 15, 16. Secy.: W. F. Ellis, Roadmaster, Providence & Worcester R. R., Woonsocket, R. I.

American Association for the Advancement of Science. The thirty-seventh meeting will be held at Cleveland, O., from August 15 to August 21, 1888. The headquarters will be at the Hollenden. For particulars address F. W. PUTNAM, Salem, Mass.

Engineers' Club of Kansas City, Mo.—Regular meeting, Sept. 3. Secy., Kenneth Allen, 19 Deardorff Building.

American Society of Civil Engineers, New York.—Regular meeting, Sept. 5. Secy., John Bogart, 127 E. 23d St.

Roadmasters' Association of America.—Next meeting at Washington, D. C., Sept. 11. Secy., H. W. Reid, Waycross, Ga.

Boston Society of Civil Engineers, Boston, Mass.—Regular meet ng, Sept. 19. "House Drainage". Secy., S. E. Tinkham, City Hall.

Engineers' Club, Philadelphia, Pa.—Regular meeting Oct. 6. Secy., Howard Murphy, 1128 Girard St.

THE railroad committee of the Philadelphia City Councils have voted to report with an unfavorable recommendation the ordinance granting the Reading Terminal Company the right to construct an elevated railroad to Twelfth and Market Streets. The committee wished to attach a clause to the ordinance obliging the company to deposit $700,000 in cash with the City Treasurer, to pay consequential damages to real estate; but under the opinion of the city solicitor this was found to be illegal. There were some other slender pretexts for finding fault with the ordinance, but they were not sharply pressed. The opposition felt itself to be so strong that it had no need to be diplomatic, and by a vote of 13 to 8 it was decided "that the ordinance be returned to Council with a negative recommendation until such time as the company will make a proposition which we deem for the best interests of the city and its citizens."

It is a question whether the citizens of Philadelphia are more to be pitied or derided. It is a pity to see a great city like Philadelphia hampered in its growth, restricted in its commerce, and made more and more undesirable every year as a place of residence, by the lack of decent transportation facilities. But the only people who are injured by this, have the remedy in their own hands. So long as they patiently submit to being packed like cattle into foul horse cars and jolted for hours every day, so long as they permit the city government to be controlled by the street railway interests, just so long will every new enterprise like the Reading Terminal project, designed to furnish cheap rapid transit to the people, be forced to the wall on one pretext or other and be heard of no more.

THERE seems to be one ray of light on the rapid transit situation at Philadelphia, however. The Law committee of Councils have voted to recommend the passage of the ordinance giving the Philadelphia & Northeastern Railroad Company a franchise for an elevated railroad from Jenkintown *via* Frankford and Tacony to League Island. The proposed route, if we are rightly informed, does not interfere with that Grand Mogul of street railway systems, the Philadelphia Traction Company, and this may be the reason why the bill was permitted to pass. One thing is certain, however, that when the advantages of rapid transit are once experienced in that city by construction of this or some other line, there will be such a demand for them that the obstructive city councils will have to respond. Even now, we believe, public opinion is strongly in favor of the Reading Terminal project and the men who killed it in councils are likely to receive a rebuke they can understand.

A QUEER performance which has only one parallel in engineering history is thus chronicled by a correspondent of the New York *Times*, who appears to be under the mistaken impression that it is wholly without precedent:

"The ten miles of new railway, over which all Persia still stands breathless with admiration, are probably destined to be as famous in engineering history as the Chinese discovery of how to roast pigs. The Shah has started to build a railway from Teheran to the Caspian Sea. Instead of beginning at the Caspian and bringing forward the rails and material on the road as it progressed, he has had all the rails and iron carried on mules across the desert to Teheran and begun there. Of the total cost thus far—£100,000—£45,000 has been for transportation expenses, and the engineering journals are laughing over it in every language of the Continent."

Precisely the same thing was done in the construction of the Mexican Railway from Vera Cruz to the City of Mexico, except that there work was permitted from both ends at once. The quantity hauled was much greater, viz., some 283 miles, against some 160 miles (60 miles in an air line) only from the Caspian to Teheran. Moreover, in hauling the rails to Mexico an elevation of over 8,000 ft. had to be overcome, while Teheran is only 3823 ft. above the sea.

There was moreover this excuse for the Mexican folly: that the work was being done by a foreign company, under a weak and unstable home government, and that it amounted to a heavy pledge of half the amount invested that the road should be built through to the City of Mexico instead of being only carried inland a certain distance and there stopped. It was in any case absurd, but not quite as absurd as the Shah of Persia's performance. However, as the construction of railways through Asia means the eventual downfall of all the existing Asian governments, the Shah is perhaps building wiser than he knows in building slowly and expensively.

THE Kutter fund has again grown handsomely this week. We trust that it may continue to do so for some time yet, but it can hardly be expected to do so indefinitely, and as we shall remit next week, the amount collected to Mrs. Kutter, we urge all those who may be intending to contribute to it to do so now, assuring them that they can never make a better use of their money. The fund now stands:

Previously acknowledged	$488
E. Wegman, Jr.	10
Wm. Thaw	20
"Holyoke,"	5
P. P. Dickinson	10
Walter Katté	5
Robert Moore	5
Clark Fisher	20
Geo. E. Mann	5
R. A. Hale	2
Geo. A. Ellis	10
Arthur Marichal	17
"Engineer"	10
Cash	5
McKee Swift	10
Total to date	$522

The prominent engineer who only figures above as "Cash" writes us:

"I send a little mite to the Kutter fund, but please note simply as "Cash" in your acknowledgement. I have not had much occasion for hydraulic formula, never having applied Kutter's in my life; but he is one of the "trade," (or profession?) and a little humanity now and then does one good."

We hope there will prove to be still others who find that "a little humanity now and then" does them good.

WE begin next week the publication of an article on "Exact Railway Location with Taper Curves", which we trust will meet the needs of a good many persons who have written us in regard to methods for putting in transition curves. The method to be given is a good one, as any method must be which accomplishes the end, but it is far from the best one, in our judgment. But as ideas in such matters differ, and as we are not yet ready to present any different method, we think it due to our readers to present this one.

The way in which the term "exact" is used, in connection with "railway location", seems to imply a misapprehension of the conditions which make good work. There is but one kind of "exact" location worth the trouble of making it,—that which is "exactly" adapted to give the best line for trains to run over at the least cost. Attention to mathematical exactitude which goes beyond what is necessary to attain this end is not only no gain but almost invariably a loss, since it diverts attention from more important matters. Accuracy is not an end in railway location, as in ordinary surveying, but only a means to attaining an end. Hence it is not good practice to habitually keep location notes to fractions of feet and minutes, and it is not of the slightest importance, for example, that the points of compounding in a "taper" curve or any other curve should fall at the rail-joints. We may add also that, by whatever method a transition curve be laid out, the final result on the track will be the same, after the road has been a year in operation, as if the main circular curve had been run in with a foot or two shorter radius at an offset from the tangents, or the tangents thrown out from the curve on a parallel offset by the same amount, and the process of running in the "taper" or "transition" curve, to connect the curve and tangent, left to the tender mercies of the trackman's eye. We do not recommend precisely that way of doing work, but the fact that it is so, should discourage over-attention to geometric minutiæ.

THE prime requirement of any convenient system of transition curves is that it should be readily adjustable to varying conditions, so that within wide limits any curve and tangent at any offset from each other (there must always be an offset of this kind if both curve and tangent are prolonged till they are parallel, to enable a curve of gradually increasing radius to be introduced) may be at once connected by a transition curve. Thus we may lay each on the ground most favorable to it, and then connect them as we find they lie, instead of being tied down to a choice be-

tween one, two or three particular "tapers" differing considerably from each other. It is obvious that there may be an infinite number of different "tapers" constructed, differing but slightly from each other. Ability to use any one of them at pleasure greatly simplifies the field work, and makes it easier than when no transitions at all are used, whereas the limitation of choice to two or three only which differ widely from each other, considerably increases the field work, and otherwise does not give as good results.

Nevertheless, the method given by our correspondent is one which will be useful to those who have not a better at their command. and it is not difficult to use; and taper curves of some kind should never be omitted in location.

Nicaragua and Panama.

The exact truth as to the result of the last Panama loan is not yet apparent. The most that is claimed by the company, is that 40 per cent. of the loan was taken, which should net some $57,600,000, from which is to be deducted at least half for the lottery and guarantee features and for one year's interest charges on past loans. Judging from the past, we may infer that the real outcome of the loan is worse even than is confessed. The past, present and future of that enterprise, from the financial point of view, may therefore be summarized as follows:

Original estimated cost, under	$120,000,000
Expended in cash to date about	200,000,000
Debt incurred prior to last loan	351,150,000
Interest and General Management per year, about	20,000,000
Probable additional cash expenditure to complete the lock canal (ENG. NEWS, June 2)	280,000,000
Admitted necessary amount for same	120,000,000
Amount secured from last loan and available for construction, let us say	30,000,000
Probable additional debt to complete lock canal	? ? ?

The discouraging contrasts of this brief statement make the early suspension of work on the Panama canal and the bankruptcy of the canal company extremely probable, a fact which naturally lends increased interest to the possibilities of the Nicaragua project; but on the other hand, the contrast in these figures will likewise tend, we may be sure, to raise grave doubts in the minds of investors, and the public generally, of the truth of any rose-colored claims in behalf of a second project in the near vicinity. The natural queries will be: Was it not claimed for the Panama also that it could be constructed at very moderate cost in a few years; and did not the difficulties prove vastly greater than expected? Has not the cost mounted up to three or four times the original estimate before the canal is half done, and the financial outcome been an ignominious fizzle? With what reason, then, can a very different result be expected from a new and longer project only a few hundred miles off? Is it not rather the rule than the exception that the cost of all such enterprises amounts to three or four times what is expected?

This is sure to be the mental attitude of thousands, who will view with great skepticism the apparently favorable showing made for the Nicaragua canal route by the maps and profiles in another column, and the very favorable estimates, into the details of which we do not now propose to enter, which show that the canal can be built in about 5 years for about $60,000,000.

We do not believe that this mental attitude, natural as it is, is in this case justified. On the contrary, there are a number of important reasons why there is no real parallel between the conditions at Panama and Nicaragua, and hence no warrant for predicting failure and excessive cost in the one case because it has occurred in the other. The project is one of such national importance and such engineering interest, and now seems so likely to be early under construction, that it will be well to consider these differences of conditions somewhat in detail, passing for the present all consideration of the exact figures of the estimate.

First, as to water supply: We discussed, in our issue of June 16, that of Panama, giving a translation of the official statement of the case. From the very face of these returns, it appears that the entire available water supply is liable to be inadequate for months together, leaving as the only available resource for operating the canal the pumping of water from the Pacific, a height of 163 ft. The provisions for controlling the Chagres when the supply is excessive are so absurdly inadequate as to be entirely impracticable even for a year. Assuming them so modified as to suffice under favorable conditions, they cannot be made permanently adequate without radical modification and much enlarged expense.

On the other hand the water supply of the Nicaragua route is absolutely protected by the natural conditions from the opposite dangers of over supply in floods and under supply in droughts. The great central lake, 40 by 100 miles long, 2,600 sq. miles in area, with a total drainage basin of only 8,000 sq. miles, serves as a natural equalizer; about as perfect a one as could be devised or desired. There is probably no other large water-shed in the world of which one-third the area drained is lake. The maximum flow of the Chagres, 1600 cu. m. per second, would only raise the level of the lake some 7 ins. per day if none of it ran out, and would only increase the normal flow of the river by a moderate percentage if all of it ran out, neither of which conditions are possible. At Panama, it is proposed to allow 16 cu. m. per second, or 14, 861,000 cu. ft. per day, for 10 lockages; and this amount cannot be supplied at low water. At Nicaragua, it is proposed to allow 129,480,000 per day for 32 lockages; and this only utilizes one-eighth of the total minimum supply, which is 11,390 cu. ft. per second, or 984,096,000 cu. ft. per day. The remainder is superfluous and must be allowed to waste, except as it may be utilized for water power. The lake, moreover, serves as a great settling basin, so that the the water supply is almost free from sediment.

Secondly, as to the climate: That at Panama is admittedly very bad, especially on the Atlantic side; largely, we presume, because there is so little wind to mitigate the heat and dissipate poisonous vapors. At Nicaragua, although much the same contrast in healthfulness between the Atlantic and Pacific slopes exists as at Panama there is an almost constant brisk east wind (the trade wind) which does not extend down to Panama, over the whole line of the canal, It is to be remembered that the route of the canal is in a sudden sharp depression in an otherwise continuous chain of mountains, which serves somewhat as a funnel to concentrate this healthful wind on the route of the canal.

This trade-wind is heavily charged with moisture and as it strikes the land is cooled and drops its moisture as rain, reaching the Pacific comparatively dry. The annual rainfall on the Pacific coast is therefore only some 3 to 6 ft., which falls almost wholly in the six months, June to November inclusive, there being 70 to 140 rainy days in the year. On the Atlantic coast it is probably about double this, as at Colon, giving a very wet climate. As in Mexico, the rain falls chiefly in the afternoon or night, however, over the whole route, so that work can be carried on equally well in the rainy season when the material permits, The clock work regularity of the weather in such regions is something which it is extremely difficult for Americans to understand.

The same is true of the equableness of the temperature. Nine-tenths of the residents of the United States and Canada think of the tropics as a terribly hot place, not knowing that they experience in their own climate every summer hotter days than the tropics can show.

The evenness of the Central American climate is indeed extraordinary, the extreme annual range being only 16° to 20°, and the extreme monthly range 12° to 18°, all between the limits of 70° and 90°. The nights, the year round, are about 70°, which is a nearly perfect temperature, and the days rarely rise above 85°, the mean of the whole year being about 81°.

It appears to be admitted and unquestionable that there are no malignant diseases, like the Chagres fever at Panama, indigenous to the region, and that the only diseases which are likely to interfere with the laboring force are an increased tendency to malarial troubles arising from turning up the soil; these are likely to be confined chiefly to the Atlantic coast, where, no doubt, they will be quite severe. But the worst section of this coast, the 12 miles from the coast to Lock No. 1, which would otherwise be likely to cause a good deal of trouble, is purely dredging work, and as this work has been executed without serious interference from sickness at the Atlantic end of the Panama canal, it is likely to be so here likewise.

Between lock No. 1 and lock No. 2 was formerly the section where there was likely to be the most trouble from sickness, but it is only 3½ miles long, and it is now converted into a basin, requiring no handling of earth except by dredging under water, as noted elsewhere. Then succeeds the great summit cut, averaging 149 ft. deep for 2¾ miles and containing nearly 8,000,000 cu. yds. Here a large force will necessarily be employed for years, but the camps for it may be 400 to 600 ft. above the sea; receiving the ocean breeze direct, and they are hence potentially perfectly healthy. There then remains no work except some dredging and dam building, and a small amount of rock excavation under water, until the 17 miles of the Pacific slope is reached, 134 miles away across the lake, on which the question of health is not likely to be one of any moment. From personal experience on the Pacific slope of Mexico we can testify that the climate is in no respect debilitating or oppressive except for about six months of the year, and then only on the coast flats, and chiefly as an effect of a varied assortment of sand-flies and mosquitoes. Once risen a hundred feet or two above the sea, these evils cease, and for a large part of the year the climate is in any case delightful. There being no coast flats at the Pacific end of the canal, we have no doubt that it will be, as claimed, an entirely healthful and agreeable place to work in.

The contrast between the climatic conditions of Nicaragua and Panama, therefore, is a very great one, and cannot but have a marked influence on the comparative progress of the works.

The third advantage which Nicaragua will have, if the works go on, is in the character and distribution of the material. All the dredging work is wholly free from rock at each end of the canal, whereas at Panama the earth dredging alone could only give about 12 ft. of water. There is a level stratum of rock in the bottom of the canal which is costing a great deal of money to remove. Moreover there are no deep cuts of earth, or mixed earth and rock, anywhere on the Nicaragua route. Whether the earth has as much tendency to slip and slide as on the heavy Panama work can only be surmised,

but it is not likely to be worse, and there is only a short part of the work, perhaps 6 or 8 miles of relatively low cutting (nowhere over 50 ft. to the bottom of the canal) on which such trouble can occur. The great summit cut of 8,000,000 cu. yds. was assumed in the previous estimates to be solid rock and estimated to cost $1.50 per yd. to excavate, wasting most of it. This seems to us a sufficient price for the work; but the recent borings show that a large part of this supposed rock cut is *tepetate*; that strange volcanic material, probably consolidated volcanic mud, which occurs in Mexico and Central America in vast quantities; which holds a vertical slope as well as rock, and which is almost as easily excavated as earth. It varies greatly in hardness. The softer varieties can be plowed like earth, but even hard *tepetate* can be bored through by a post augur, and is shaken into the equivalent of earth, so as to be readily handled by steam shovels, by heavy charges of black powder buried in chambers. Should half of this great cut, more or less, prove to be *tepetate*, the saving in time and money for constructing it would be a very important one.

Finally, the last and greatest advantage which the Nicaragua canal will have, the importance of which it would be difficult to exaggerate will be in the quality of the management. We are reluctant to seem to cater or give way to national prejudices. Every nation has its strong points, and the French have many; but the past certainly does not indicate that among them is to be numbered any great aptitude for,or skill in the conduct of great public works, especially in those embodying unusual or exceptional features. Their first railways were built by English contractors; the Suez canal was rather a diplomatic than an engineering triumph,the technical management having been anything but good, and the cost excessive; and the management of the Panama Canal must certainly be admitted to have been disgracefully bad from first to last, in many important respects.

The first and fundamental error was in selecting the route at all, and still more in starting work on it,until it had been thoroughly surveyed, and at least one other route likewise. Prudent men, undertaking the project in a business way, would never have done this. Nor would they have fallen into the second great error, of giving weight to purely sentimental notions about the importance of a canal without locks, when it was an undeniable fact, repeatedly pointed out, that the few necessary locks, aided by modern hydraulic machinery, made only a few hours difference in voyages of weeks and months; hence no difference in the revenue and evidently little in operating expense; so that instead of planning to spend tens of millions and actually spending a hundred or more to get rid of locks, a few million dollars was the utmost justifiable expenditure to dispense with them.

The subsequent management can only be described as what might be expected from such a beginning. Nearly eight years have passed since work was begun, yet it is carried on to-day as it was in the beginning, on the Scriptural basis of "Take no thought for the morrow. Sufficient unto the day is the evil thereof." The integrity of the whole work depending on the control of the Chagres, and that involving enormous expense, the obviously proper thing to do was to attack that, and the great Culebra cut first, with the comparatively small force and plant, which could alone be employed on them, leaving the undertaking of the lighter work till there was prospect of completing the heavier work simultaneously with them. Not only was this not done, but it was two years before records of the flow of the Chagres began to be taken. It is useless to particularize the other errors: the letting of the lightest and simplest work first, which should hardly have been touched to-day; the excessive purchases of costly plant, much of which has never been and will not be used at all; the adoption of a needlessly heavy (70 lb.) construction rail, so high and so narrow on the base as to give constant trouble, and the purchase of such a preposterous amount as a thousand miles of it; these and a long list of other errors of management are already on record.

Above all, the absurdity of taking four or five years to find out, and two years more to admit, that the sea level project was absolutely impracticable, when it ought to have been evident from the first, and was declared to be by the engineering profession the world over, except by the knot of French enthusiasts intoxicated by the success of Suez,—this was an error which it is difficult to think of with patience or speak of with courtesy, since it admits of no excuse and involves the ruin of thousands of innocent (decidedly innocent) investors.

The one redeeming feature in the history of the canal, the one thing which can be or is pointed to with pride even by the management itself, is the smooth, business like and systematic way in which the American dredging company has carried out its contract, and completed its work. Like most of the contracts of the Canal Company, it was immensely favorable to the contractors; it was also made about seven years too soon; but so far as the contractors themselves were concerned, the handling of this part of the work has been wholly creditable.

It is surely a favorable augury for the construction of an entire canal under American auspices, that American contractors should thus have carried off the only honors of a French enterprise, and should this augury be fulfilled, as we believe it will, if the Nicaragua Canal Co. secures the money to carry out its work, it is not too much to say that it will be an event of national importance indirectly, in the world-wide reputation it will give to American contractors, as well as directly as an individual enterprise. This country is full of men who are capable of managing the largest contracts successfully, while we cannot but believe that there are very few men here who could take heavy contracts at all, who would manage them so unsuccessfully as the Panama contracts have been managed.

For one thing, the company will be in a position to make a very shrewd contract for its dredging work, since they may utilize without cost the otherwise useless plant and experience gained at Panama, which enable a crew of 20 men and boys to throw out 10,000 cu. yds. of earth a day. The profits of these dredges at Panama have been fabulously great; so great that we do not like to put them on record in cold print, knowing them only by hearsay, yet tolerably well. As the occupation of these great dredges will be gone with the completion of the Panama contracts, the owners of them can well afford to take further contracts at any price which will pay a good profit over running and maintenance expenses only.

The demoralizing error of heaping up $20,000,000 worth of plant to be used or abused at pleasure, and turned over free to contractors, is likewise not likely to be repeated. In that and many other ways the company is likely to profit by the warning of Panama, if it would not otherwise be so cautious.

Therefore, with no difficulties of climate, no difficulties of water supply, no difficulties from enormous earth cuts, no torrents to control, no absolute absurdities of management to fear,and probably far less difficulties of labor supply, although that may be a serious difficulty; and with the volume of material of each class known with tolerable certainty in advance, we see no reason why there should be any great question about the total cost of the work, except the fundamental one of what the material will cost per cubic yard or other unit. By "great" question, we mean a difference of more than 10 or 20 per cent. beyond the usual percentage for contingencies, which on this work is very properly made 25 per cent., instead of the usual 10 per cent. On this basis, the estimate (of 1885 which is soon to be revised according to the recent surveys) foots up $64,043,699, made up as follows:

Quantity estimate at $1.50 per cu. yd. for rock; $5 for rock under water, 40 cts. for earth, 20 cts. and 40 cts. for dredging, $6 and $9 for concrete, $2 for stone pitching, $1.50 for stone in breakwaters, 75 cts. for puddle,and 50 cts. per cu. ft. for timber	$51,234,959
Surveys, hospitals, ships, management and contingencies, 25 per cent	$12,808,740
Total estimated cost of canal	$64,043,699

This total may easily be 10 or 20 per cent. too small; the chances are that it is. Some of the prices and quantities seem more than ample, as we have noted elsewhere, but others seem rather small, while the harbor work at each end may cost two or three times the $3,400,000 allowed. But there is at least some allowance for every known and definite expense herein, and adding 20 per cent. more to every item, or 50 per cent. in all, the aggregate reaches only $77,000,000. That the canal can be finished for about that sum in actual cash expenditure we see no reason to doubt, and if so, it will beyond question be an extremely profitable enterprise even if the Panama Canal were likewise completed, for at equal tolls all the sailing vessels would take it because of the more favorable winds, and a large part of the steam vessels, because of the shorter distance, fewer locks and easier navigation. This we think becomes very clear if the character of the work be considered in detail, but we must postpone any attempt to so consider it, if we do so at all, to a future number. For the present we simply note that the traffic now claimed for Panama is about 10,000,000 tons at $3 per ton tolls. The traffic which is pretty certainly "in sight" is about 4,500,000 tons, which at $2.50 per ton will afford a revenue of $11,250,000.

PERSONAL.

A. E. MUNN, contractor, of Wichita, Kan., was drowned at that place July 7.

A contractor named KENNY, working on the Canadian Pacific line in Maine, was shot and killed near Monson, Me., July 4.

At Providence, R. I., an ordinance has been passed creating the office of Commissioner of Public Works.

DAVID BROCK, Division Superintendent of the Chicago & Alton R. R., at Roodhouse, Ill., has resigned.

CHARLES HOWARD, Superintendent of the Providence & Worcester R. R., has been appointed General Manager of the Howard Burton Stock Car Co. He will retain his connection with the railroad.

J. H. PARSONS, General Superintendent of the Chicago & Atlantic Ry., and formerly Superintendent of the Lake Shore & Michigan Southern Ry., has been appointed General Superintendent of the New York, Lake Erie & Western R. R., with headquarters at Hornellsville, N. Y.

The office of Chief Engineer of the Ohio & Northwestern R. R., has been abolished, and all communications addressed to that department will henceforth be sent to T. G. BOTHWELL, Roadmaster.

SAMUEL STILLWELL DOUGHTY, a former resident and well known surveyor of New York City, died recently, at the age of 78. At an early age he became connected in business with his father, EDWARD DOUGHTY, then City Surveyor. He subsequently laid out many of the streets of upper New York and assisted in the surveys for Central Park. In 1844 he was appointed a street commissioner.

D. McN. STAUFFER of this journal returned from Europe by the *Germanic* on Friday.

CHARLES DUNLAP has been appointed Superintendent of the Chicago, Kansas & Nebraska R. R.

J. B. GREEN has been appointed Superintendent of the Missouri Pacific R. R., with headquarters at Memphis, Tenn.

WEBSTER SNYDER, General Manager of the Gulf, Colorado & Santa Fé R. R., has resigned. The resignation will take effect Aug. 10.

Major R. A. BACON, of Columbus, Ga., has been appointed Superintendent of the Rome & Columbus R. R.

THEO. D. KLINE, Superintendent of the Southwestern division of the Georgia Central R. R., has resigned his position.

W. G. SALA has been appointed Assistant Superintendent of the South and North division of the Louisville & Nashville R. R.; to succeed F. W. DUNN.

CHARLES B. JACOBSEN, formerly with the Norfolk & Western R. R., has accepted the position of City Engineer at Roanoke, Va.

The President has sent the following nomination to the Senate: Col. THOMAS L. CASEY, Corps of Engineers, to be Chief of Engineers, with the rank of Brigadier General.

FRANK M. LILLIE, of Youngstown, O., has been appointed Roadmaster of the Pittsburg, Youngstown & Ashtabula R. R. between Youngstown and Kenwood, Pa., with headquarters at Lawrence Junction.

JAMES T. GARDNER, late General Superintendent of the Buffalo & Pittsburg road, has been appointed General Manager of the Lehigh Coal & Iron Co. in the West, with headquarters at Minneapolis, Minn.

A. M. WELLINGTON left New York on Thursday, July 12, with his wife and daughter, for a six weeks' absence in the Canadian Rocky Mountains and on the Pacific coast. His address for two weeks will be C. P. R. Hotel, Banff, Canada, and for two weeks thereafter Driard House, Victoria, B. C. He will return to New York about Sept 1.

CORRESPONDENCE.

A Correction.

LAWRENCE, Mass., July 5, 1888.

EDITOR ENGINEERING NEWS:

Referring to my letter of correction of May 26, in regard to the use of the weir formula, in Mr. LEDLIE'S paper, I am informed by Mr. L. that the error of stating that h was the depth in *inches* was a typographical error, and that the depth was used in the calculations, in feet, correctly. If you will state this in justice to Mr. L. you will oblige.

Yours truly, R. A. HELE.
Hydraulic Engineer

A Question of Dynamics.

LOWELL, Mass., June 28, 1888.

EDITOR ENGINEERING NEWS:

In your issue of June 23, you allude to a discussion which appeared in your journal some time ago on the collision of two bodies.

Your position was that if two trains of equal weights collide, with velocities of 30 miles per hour, the crushing and breaking would be only one-half as great as it would be if one train was at rest while the other was moving at the rate of 60 miles per hour.

I agree with you that the total energy of the motion in the former case would only be one-half as great as in the latter, but it does not follow that the energies directly lost by the two collisions would be in that proportion. Except in the case where the trains collide with equal velocities, only a portion of the total energy is directly expended in the collision. The remaining energy is expended while the trains are *gradually* brought to rest, and although this might cause a certain amount of crushing and breaking, its amount would be utterly insignificant in comparison with that caused directly by the collision. Finally if authority can have any weight I appeal to JULIUS WEISBACH, who gives a solution of this identical problem in the first volume of his *Mechanics*, page 676, as follows:

"If two trains of cars, weighing 120,000 and 160,000 lbs. come into collision upon a railroad when their velocities are 20 and 15 ft. [per second. ED.] a loss of mechanical effect, which is expended in destroying the locomotives and cars ensues; its value is

$$= \frac{(20+15)^2}{64.4}\left[\frac{(120{,}000)\,(160{,}000)}{120{,}000+160{,}000}\right] = 1{,}304{,}350 \text{ foot-lbs}".$$

In this solution, as given by WEISBACH, the result happens to be equal to the total energy in the trains before the collision, because the weights of the trains are inversely as their velocities, and hence the resultant velocity after the collision must be zero.

But suppose the train which weighs 160,000 lbs. to be moving at the rate of 60 miles an hour, or 88 ft. per second, while the other train is at rest; then from the same formula we obtain as the energy lost by the collision:

$$= \frac{(88+0)^2}{64.4}\left[\frac{(120{,}000)\,(160{,}000)}{120{,}000+160{,}000}\right] = 8{,}245{,}608 \text{ foot-lbs}.$$

But the total energy in the moving train before the collision was 19,239,753 ft.-lbs., showing that more than half of the total energy still remained after the collision; but this larger portion would be overcome by the resistances of gravity and friction in gradually bringing the trains to rest, and its destructive effect would not be comparable with that caused by the direct collision.

In regard to the illustrations which you give of the results of the impact of two bullets, in which the larger one was at rest, I venture the opinion that the reason why the large bullet only was battered was not because it was at rest, but was due to their difference in shape and quality of material.

Yours truly, F. GILMAN.

[If the two trains, after colliding, were at liberty to sail away through space like two planets colliding, in a manner to correspond with theory, or if they could be assumed to sail along peaceably up the track until "the resistances of gravity and friction gradually brought the trains to rest", so that "its destructive effect would not be comparable with that caused by the direct collision", as our correspondent alleges would be the case, there is no doubt that he is on unassailable ground, it being quite different from any that has been assumed heretofore. The fact is, however, and it has heretofore not been questioned, that the colliding bodies after collision do not glide off thus peaceably together. In the effort to adjust their motion to theory in the act of collision the leading vehicles get badly bruised and smashed, convert themselves into a scrap-heap and wood-pile resting on the ground, instead of vehicles resting on wheels, and hence, although there is usually from 100 to 500 ft. motion after collision in the direction that theory indicates, yet it is not enough to account for any appreciable fraction of energy which is practically all dissipated in either case in destructive work. The position heretofore, and a very erroneous one, has been that two trains colliding at 60 + 0 miles per hour were not potentially capable of doing any more destructive work upon each other (although they might be on "a log of wood or bank of earth") than if they collided at 30 + 30 miles per hour; not that in the first place they would only dissipate a part of their energy and retain the rest as motion.

As to the bullets we illustrated, when our correspondent will produce some bullets showing like effects with the conditions of motion and rest reversed, we shall believe him. ED. ENG. NEWS.]

EDITOR ENGINEERING NEWS:

As one of the heretics who ventured to dissent from your position on the question of the colliding trains in April 1887, I beg to report that I am still out, notwithstanding the bullet experiment illustrated in your issue of June 23.

In the absence of experiments with the small bullet at rest and the large one in motion, I do not see that we have any additional light on the subject. Unfortunately I am not in position to make the needed experiment, but would suggest something like the following: At one end of a horizontal board in your editorial sanctum place a piece of soft cheese, say a cube of 6 or 8 ins. Against the face of the cheese cause a marble to impinge horizontally at a velocity of 60 miles per hour, by allowing it first to roll down an inclined plane such as will give it that speed. Observe the depth to which the marble penetrates the cheese. Now transfer the apparatus to the baggage car (parlor car people are so fastidious) of an express train, with the *cheese* end of the board *away* from the locomotive. When the train is moving 60 miles per hour discharge the marble as before, at 60 miles per hour in the opposite direction. The marble will then at the moment of collision be standing still over some point in the track and the cheese will come up to it at the rate of 60 miles per hour. So far from its "wiping out" the "little ball" I think it will "scoop it in", and to just the same extent as before.

Now repeat the experiment when the train is moving at 30 miles per hour. Then the marble and the cheese will approach each other, each moving 30 miles per hour. According to your theory [not at all. ED.] the marble should now penetrate only half as far as before; the energy being proportional only to $2 \times 30^2 = 1{,}800$ instead of to $60^2 = 3{,}600$.

But in fact I do not think it will.

And, to revert to the original question, I think you will find no difference, under these several conditions, as to the tendency of either the marble or the cheese to *climb* up over the other, as the moving engine climbed upon the standing one.

SKEPTIC.

[If our correspondent would make the experiment with the small bullet at rest and the large one in motion he would perhaps receive some "additional light on the subject". In part he is answered above? His elaboration of the problem by putting his cheese and marble on the train does not effect the matter in the slightest. All bodies in the universe are in rapid and complicated motion and have that mysterious something called energy stored in them proportionately. Were the earth to suddenly stop, the energy thus stored in the buildings and people on its surface would carry them sailing off into space; but in the meantime marbles, cheeses, people and all are at rest relatively to the earth except as they may be put in motion by other forces. Substituting a moving train for the moving earth as the body on the cheese rests, is merely substituting a new earth for the old. The new energy thus stored in the marble and the cheese does not count and is not called out in their collision any more than that due to the motion of the earth is. Whether on the earth or on the train the marble impinges on the cheese with precisely the energy due to the vertical distance though which it has fallen. As this by assumption is the same in each case, the energy of collision likewise is the same in each case.

As to the closing statement: Is there not evidence in the pictures of the consolidated balls which we published as to which body was in motion and which at rest? When our correspondent can produce a single instance where engines colliding at equal velocities have failed to suffer about "equal and similar" effects as respects their final position when they came to rest, then we shall be prepared to admit that there was not evidence in the picture which we published as to which engine was in fastest motion. Until then we must now drop the matter. No doubt it is conceivible that an engine in motion *might* plow under one at rest, but they do not do it. ED. ENG. NEWS.]

CEDAR FALLS, Ia., July 3, 1888.

EDITOR ENGINEERING NEWS:

I send you herewith specimens of bullets which I think offer conclusive evidence upon the "Question of Dynamics" you have discussed in your columns. The specimens you illustrate being of different size and shape must necessarily be acted upon differently and hence do not prove anything pro or con. In the experiments I performed the balls were of equal size (38 calibre) and spherical. One was fired from a rifle with a small charge of powder, the other being held in front of the muzzle about three inches from it between two sticks tied around the barrel and projecting beyond the muzzle. The bullet was placed in a hole in a piece of pasteboard and the

latter adjusted between the sticks so as to hold the bullet as exactly as possible in the axis of the bore. They were fired into a bag stuffed with rags. The bullet which was held in front of the muzzle was marked with a cross cut into it to distinguish it.

In specimens *A*, *B* and *C* the struck bullet was slightly the more flattened; in specimen *D* the two are flattened almost exactly alike; in specimen *E* the two bullets are very much flattened, a larger charge of powder having been used. The striking bullet is somewhat the more flattened. When found the two adhered closely together but have been partly separated. The three specimens *F*, *G*, and *H* are the result of two experiments, in the first of which *G* was fired against *F*, *F* being considerably damaged while *G* was only slightly flattened, as seen on the convex side of the specimen. This seemed to indicate that *G* was harder than *F*, so in the next experiment *H* was fired against *G*, the result being that *H* was much the more flattened. In the last experiment pieces of the paper bag against which they were fired were found adhering to the bullets and have been secured to them by mucilage exactly as when found. The papers adhered to the flat sides of both, from which it is evident that both struck flat side foremost, and the struck bullet must have made a half revolution before striking the bag, which was at a distance of about one foot.

These experiments seem to prove conclusively that when both bullets are of equal hardness they will be equally flattened. That the striking bullet is the less flattened in a majority of the experiments may be due to the fact that it generally required a slight ramming to force it to the bottom of the bore, the ramming considerably increasing the hardness of the surface of impact.

That the two bullets must be equally flattened follows from the law that action and reaction are equal. If the forces they mutually exert upon each other are equal why should they not be equally flattened? The force of impact depends only upon their relative velocities, and not upon their absolute velocities, or their velocities with reference to the earth, for they are moving independently of the earth and the earths motion does not enter into the problem. The same amount of energy is transformed into heat by impact whether one, moving with a velocity $2v$, strikes the other at rest, or whether they come together each with a velocity v, or whatever their absolute velocities, if their relative velocities are the same, as is shown by the formula quoted by F. GILMAN in your issue of June 4, 1887. It is true that in the former case the combined energy is twice as great as in the latter; but in the latter case all the energy is destroyed and both bodies come to rest, while in the former case the two bodies continue to move with a velocity v. Their combined energy is then one half that of the striking body, the other half having been destroyed by impact or exactly as much as in the latter case.

When a train in motion strikes one of equal weight at rest, the two continue in motion with half its velocity and only half its energy is destroyed *by impact*. Of course it is all ultimately destroyed but more gradually than by impact. The amount of crushing and breaking depends not only upon the *amount* of energy destroyed but also upon the suddenness with which it is destroyed. If the cars are derailed or the trucks knocked from under, some further damage may be done, as in ordinary derailments, besides that due to impact, before they come to rest, but it will not necessarily be as great as if all the energy were destroyed by impact. If the cars are not derailed they will come to rest gradually by the ordinary frictional resistances and there will be no more damage done than in the case where two trains come together with equal velocity, the relative velocity being the same. Yours truly,

WALTER BRYANT.

[Owing to the difficulty of engraving so many samples properly, and as our correspondent's description of what they show is clear and correct, we do not give them graphically. The difference in effect on the bullet in motion and the one at rest, although perceptible, certainly admits of explanation as above suggested. On the main question of the effect of collisions, however, bodies like bullets which are free to sail off through the air unimpeded after collision are not fair evidence, the fact being that the train is always so wrecked that there is very little motion backward from the point of collision, and all the energy is expended almost as instantanously when one train is standing still as when two collide at equal velocities. Supposing the two engines collide with velocities of 60 and 0, and expend only half their energy on each other, the other half tending to keep them in motion at 30 miles an hour; instantly follows another collision between the engines and the train on each side at 30 miles an hour, and the two together pile the whole train up in a wreck, or enough of it to forthwith exhaust the whole remaining energy.—ED. ENG. NEWS.]

Contraction and Expansion of Ice.

Beaver Dam Water-Works Co.

BEAVER DAM, Wis., July 9, 1888.

EDITOR ENGINEERING NEWS:

Are you right in your statement in regard to ice contracting by cold and expanding by heat? I have always supposed that ice expanded by cold in some fixed ratio and contracted as the temperature rose. That cracks formed as temperature rose, or as I have heard old dwellers on the lakes say, "booming ice means a thaw", refering to the noise made by the ice cracking. If I am wrong please tell at what temperature ice ceases to expand with loss of heat, and expands by warming. These questions are suggested by your query on page 539 in ENGINEERING NEWS of June 30. Respectfully yours,

E. G. FERRISS.

(There is no temperature at which ice expands with cold. Water in the act of solidifying into ice expands very largely, but this is the effect of the whole molecular change and not change of temperature, which remains constant. After the ice is once formed, loss of heat causes it to contract like other solid bodies, and increase of heat (to not exceeding 32°) causes it to expand. The cracking of large fields only occurs, so far as we know, in severely cold weather, and is only a sign of a thaw in that such weather is usually followed by warmer. ED. ENG. NEWS.)

STURBRIDGE, Mass., July 4, 1888.

EDITOR ENGINEERING NEWS:

Your request in issue of June 30 leads me to state a case of ice expansion, and of its practical effect on a dam, that was called to my notice professionally a short time ago.

The dam was built some years ago to hold water for manufacturing purposes. It was about 120 ft. long, 12 ft. high, with retaining walls on front and back side, placed 16 or 18 ft. apart, and filled in with gravel. Ledge and filling on the water side reduced the height of the walls to 6 to 8 ft., except for a short space in the middle.

On examination, I was much surprised to find a part of the wall on the lower side had fallen out, while the lower courses of stone retained their place. I also found that the portion standing was overhanging from 2 to 4 ft. Judging from appearances, the wall was originally laid with a vertical face of good size, flat ledge stone, and had a good strong cross section.

Thinking this dam should not show such a weakness under the ordinary ice pressure, I looked about for a solution. The pond turned sharply to the right, 200 or 300 ft. above the dam. The shore was bold and ledgy. My conclusion was that, the ice being unable to slide on this shore, the dam, as the other abutment, was gradually forced back. Further, that a dam with a proper slope on the water-front would allow the ice to slide, and would stand, or a curved masonry dam, even with light section would hold, as both abutments would be ledged. I think a straight dam with a vertical water-front would have to show a very heavy cross-section to keep its place here. I have made no figures as to the expansive force of ice in this case, but have had occasion to notice its practical force in displacing flumes, gate-chambers and stems where exposed to large areas. But the above is the most noticeable effect of ice expansion on dams I now recall. If these facts will in the least aid to bring out fuller information on the subject in your columns, I shall, as an interested reader, receive ample recompense. A. C. MOORE, C. E.

ENGINEERING NEWS.

THE city of Chaux-de-Fond, in Switzerland, is supplied with spring water which is raised by pumps 490 meters. The quantity of water is 3 cu. meters per min. As this enormous pressure would soon cause the air in the air-chamber to be absorbed a very simple method has been adapted to constantly replenish the same. At the lowest point of the pumping main, about 5 meters below the air-chamber, a pipe leads into a wrought steel vessel holding 650 litres, and from this vessel a pipe leads to the air-chamber. Proper valves allow the vessel to be filled with air and then to be subjected to the pressure from the pumping main, which is about half an atmosphere greater than at the air-chamber. This causes the air to flow into the latter and thus to keep it filled.

THE proposed extension of the water supply of Vienna is estimated to cost $8,000,000. Half of this sum is to be devoted to an increase of the present gravity supply of drinking water from Alpine streams; the other half is to be applied to the laying of a separate system of pipes and pumping plant, to supply water from the Danube opposite the city, for street, fire and washing purposes.

A NOVEL method of locating a leak in a water main was employed recently at Rochester, N. Y., with entire success. The break in the main was known to be between the banks of the river. A solution of bi-permanganate of potash was introduced at a hydrant on the side of the river nearest the reservoir, and observers were stationed on the river along the line of the main. A deep reddish purple discoloration of the river water at one point soon made the exact location of the leak apparent.

Superintendent SHANAHAN rejected all the bids recently made for dredging at various points on the Hudson river, because the average price asked by the five bidders was about three times that paid in the past. Active competition has heretofore kept the price about as low as the work could be done for, ranging from 9 to 15 cts. per cu. yd. This year the bids ranged from 33 cts. to more than 35 cts. per cu. yd. clearly indicating that a combination or trust had been instituted, and so the proposals were rejected and the work readvertised.

IN California, it is probable that $15,000,000 will be spent in the next twelve months on the irrigation districts already organized and those to be started. It is estimated that this expenditure will increase the value of the lands irrigated about $100,000,000.

WOOD pavements have met with greater success in Europe than in America, because they are laid upon a foundation of concrete, and receive more attention in the way of maintenance than is given them here. American yellow pine, owing to its hardness and resinous quality has been the favorite wood in Berlin and Hamburg. A report from Berlin states that the Frederick's bridge was paved in March 1879 with yellow pine and is still in a good condition while the approaches paved with granite blocks have since required twice repaving. The Opern platz in front of the Emperor's palace was paved in 1882 partly with yellow pine and cypress at the point where the traffic is greatest. At other points stone blocks were used, and were laid at the same time. To-day the area having the wood pavement is the one which is best preserved.

THE City Council of Berlin has decided to publish a map of the city to a scale of 1:4000, drawn with great accuracy and showing not only the streets, open places, watercourses, etc., but every property with its boundaries and the ground plan of the buildings upon them. Similar plans in large scales are already published of London and Paris. It is time that in our country we should consider the advisability of publishing accurate detail maps of our largest cities. They would be of use for a large number of purposes.

AT Ansonia, Conn., it is reported that the Naugatuck river receives so much of the escaping current from the electrical railway near its bank, that at one point an invigorating electric bath can be had by taking a plunge in the water. A large quantity of electricity is escaping all the time, the amount varying with the amount of work required to run the car on the various grades. A local electrician is said to have tested the power of the current and found that at times it was sufficient to run an Edison incandescent lamp, which requires for normal running a current of 120 volts. He grounded a wire near the generating plant, but not in connection with the track, and carried it to his office three miles away, making a connection with the gas pipe. The wire was cut and a 16-candle power Maxim incandescent lamp inserted, requiring, for normal running, a 50 volt current. The light, though unsteady, was up to the rated power most of the time. With the more powerful Edison lamp the light was also sufficient to read by.

THE Chamber of Deputies has voted by 192 to 68 that about 1,870 miles of new railway in Southern Italy shall be constructed by the Government at a cost of some $40,000,000,

THE London *Times* says that an important practical innovation in the glass bottle making trade has been perfected. This is Ashley's ingenious apparatus for mechanically moulding and blowing glass bottles. The moulding is done mechanically, and the blowing by means of compessed air, thus relieving the glassblower of his unhealthy and life shortening occupation.

THE manufacture of bricks is a subject of considerable importance to engineers and one in which they take considerable interest, as was evinced by the active discussion on this subject at the recent Convention at Milwaukee. A general invitation was given for members to attend the annual meeting of the Association of Brick Manufacturers at Memphis, Tenn., in November, and we would suggest that all engineers who can should make a point of attending this meeting and lend their aid to the improvement of this important industry.

THE boiler of the first locomotive that ever turned a wheel on the American continent, the Stourbridge Lion, made by Foster, Rastrick & Co., Stourbridge, England, is in daily use in a foundry in Carbondale, Pa. The looomotive was run in Honesdale, Pa., Aug. 29, 1829. HORATIO ALLEN, who ran it, is living in Orange, N. J. aged 86 years.

SOCIETY PROCEEDINGS.

American Society of Civil Engineers.—*Milwaukee Convention* (*Continued from page* 18). On Friday, June 29, the meeting was called to order between 10.30 and 11, and after some announcements with regard to excursions, etc., the subject of "English Railroad Track" was declared open for discussion. The discussion started rather wide of the subject, however, and bore principally upon car capacity and weight of rails. Mr. J. T. DODGE opened the discussion by a brief paper on the destruction of rails by excessive weights. He referred to diagrams of sixteen pairs of rails much worn by use. The sections were taken with a view of shedding light upon the proper radius of the corners of rail-heads and the flange fillet of wheels.

"The significance of the diagrams for the purpose intended is very marked, but they convey a lesson of still more definite import in showing conclusively the flow of the metal of the rails under the excessive weights constantly passing over them. On the rail of a fast-speed tangent no lip is perceptible on either rail, but on like rails for slow speed the lip is clearly visible. On the rails of a fast-speed curve there is a heavy lip on the outside of the inner rail and only a very slight one on the outside of the outer rail. On a slow-speed curve the lip upon the outer rail is more marked and on the inner rail a little less so. These facts harmonize with what is to be seen in almost any railroad yard, the speed being slow and the destruction of the rails by the flow of metal enormous. It has been argued that because in a certain experiment where a pressure of 53,760 lbs. per sq. in. was applied to a piece of soft iron by a steel die ¼ in. square before producing a perceptible indentation, therefore an engine or car wheel on a steel rail cannot produce any distortion of fibre. Now the argument is good in its place, but it cannot controvert the facts before our eyes. That the metal of rails flows under the weight of the wheels is a fact of observation. That those weights are excessive is a conclusion of reason. No form of rail can be devised which will insure any definite area of bearing for each wheel. These bearing areas will vary as the radii of the wheels. They should also vary as the width of the rail heads, and will vary according to the condition of the tire, some being flat and some concave by wear. Car-wheels are usually coned, drivers are not; hence by no probability will all the wheels of a train have the same contact with any one rail.

"The conclusions deducible appear to be as follows: Diameters of wheels should be as large as practicable; rail heads should be as wide as practicable; tires should be kept as flat and perfect as practicable. As to the diameter of the wheels, the area of contact of wheel with rail being directly as the diameters, the weights to be carried should decrease in like manner. Hence, an 8-wheel freight car weighing 25,000 lbs., when loaded with 41,000 lbs. additional, will be fully as destructive to the rails as a consolidation locomotive carrying 96,000 lbs. on its eight drivers of 4 ft. diameter. In view of the fact just stated, the tendency to increase the weight of rolling stock seems to me to have passed its proper limits and that we should call a halt."

Capt. RICH, Chief Engineer of the Minn., Sault Ste M. & At. Ry., stated that he had increased the capacity of cars from 40,000 to 50,000 lbs. and found it too heavy. He thought the maximum should be 40,000, and 60,000 far too great. Mr. RODD stated that cars of 80,000 lbs. capacity had been used on the Pennsylvania road for special purposes, but had been run over all parts of the road; these cars are 30 ft. long, carried on 12 wheels, and have a gross load of 128,000 lbs. He thought the capacity of cars will continue to increase, owing to the greater cost of the cars, for which reason more work must be got out of them. Mr. PERCIVAL ROBERTS referred to the fact that cars are often unequally loaded, so that the load is sometimes all on one truck; this is experienced sometimes in carrying long pieces of bridge work which extend over two or three cars. In answer to a question he stated that in loading bridge material on cars it was not general practice to block up so as to have an auxiliary system of support additional to the support at two points which is required in order to allow of the swing of the cars on curves; the reason for this he attributed to the expense of the "false works". Mr. GOTTLIEB, however, had known of this being done. Mr. OBERLIN SMITH thought that the vertical motion of the cars would hinder a proper distribution of the load, and suggested the use of cross timbers above and below the girder to be carried, with car springs placed between the timbers and the girder, forming a bolster. With regard to the loading of bridge material, Mr. SKINNER stated that the sections for the steel arches of the Harlem Bridge were 18 ft. long by 11 ft. deep and could not be hauled on ordinary cars through the tunnels of the Erie road to New York. Gondola cars were used and slots cut in the floors, the arch section being suspended within a foot of the rails and being supported at each end by frames bolted through the rivet holes of the bridge work and reaching to the underside of the top chord

Mr. MENDES COHEN here reminded the members that the discussion was wandering away from the subject. During the last 20 years the loads of cars have been steadily increased and in some cases it has been necessary to put down heavier rails to carry the increased loads; but these same cars have to be hauled over connecting lines with a lighter track, which practice may reach a dangerous extent. There always is and always will be a struggle over the relations to each other of car loads and track, but in his opinion the car loads have reached their limit, for the present at least, and now the weight of rails should be increased to meet the requirements of these loads. Mr. FRANCIS thought that flow depended upon the load on one point of the rail. Mr. BECKER referred to the rapid increase in car capacity: in 1850 the average rail was 50 lbs. per yard and the average car load 10 tons; now the car loads are 30 tons, an increase of 300 per cent., while the weight of rails has only increased to an average of 75 lbs., an increase of only 50 per cent. Mr. DODGE expressed his opinion that the rail in itself was strong enough, but the metal takes a set. Wider heads would not be of much use, as all the wheels of a train do not wear to a uniform bearing area on the rail, and the edges of wider heads would be crushed. Prof. JOHNSON stated that the distortion of a plastic body has no relation to force, but to time. He suggested the rolling of the rails with the top of the head having an inward inclination to conform to the coning of the wheels, with regard to which Mr. GOTTLIEB and Mr. TRATMAN alluded to the European practice of tilting the rails. Mr. JENNINGS expressed his opinion that specifications for steel rails were not close enough, being looser than specifications for any other article manufactured of steel. He thought they should allow more limit as to the percentage of carbon, but should be more rigid as to drop tests. Remarks on the subject were also made by Messrs. BASSEL, WILSON, LOWETH and CROES.

Mrs. FRANCIS then moved a vote of thanks to the ladies of Milwaukee for their hospitality and for the courtesies extended to the members of the Society and their guests. This was carried with enthusiasm.

Mr. WHITTEMORE introduced to the Society Mr. GRATZEL, of Hanover, Germany, who has paid much attention to the magnesium light, and who has succeeded by his efforts and investigations in largely reducing the cost of the metal from which the light is produced.

Mr. JENNINGS, on behalf of the Ohio Institute of Mining Engineers, of which he is President, invited members to attend the summer meeting of the institute at Logan, O., July 11 and 12.

THE BUSINESS SESSION.

The afternoon session was opened as a business meeting, at which the reports of committees were presented.

The Committee on Standard Time reported that progress was being made. Accompanying the report was a treatise on "Time, and its Notation," for the use of schools, which had been prepared by Mr. SANDFORD FLEMING, Chairman of the committee, who suggested that the Bureau of Education be recommended to adopt this as a class book in public schools, for the purpose of familiarizing the coming generation with the 24-hour system. The treatise was referred to a special committee, consisting of Mr. FRED. BROOKS and Mr. PERCIVAL ROBERTS, which is to report to the Society on the merits of the treatise. The regular committee was continued.

The Committee on the Compressive Strength of Cements, etc., presented a long and valuable report, but as it was full of tables which could not well be read, it was accepted as read and ordered to be printed and the committee was continued.

The Committee on the Proper Relation to each other of Railway Wheels and Rails reported that a long and elaborate report was now nearly ready to be read before the Society, but it could not be done at this convention. This committee was also continued.

The Committee on Grades and Titles of Engineers on Public Works recommended the following titles, in order of precedence: Chief Engineer, Chief Assistant Engineer, Division Engineer, Resident Engineer (in direct charge of work in progress) and Assistant Engineer. The too frequent use by inexperienced men of the term "consulting engineer," was deprecated. Mr. WHITTEMORE explained the reasons for the committee's action, and the report was referred back to the committee to be perfected.

The next proceeding was the appointment of a nominating committee to select the candidates for the president for next year. The same arrangement was made as last year, the members from 5 geographical districts forming groups in different parts of the hall and selecting one member of the nominating committee. The geographical divisions, however, were somewhat different from those of last year, the divisions and their representatives on the nominating committee, being as follows:

New York City and 50 miles around, W. G. HAMILTON.

New England, rest of New York and Canada, F. P. STEARNS.

Pennsylvania and South Atlantic States, ALEXANDER DEMPSTER.

States South of the Ohio river, including Missouri, Kansas and Colorado and the Pacific slope, W. B. KNIGHT.

States North of the Ohio river, and the Northwest, Major A. B. ROGERS.

This arrangement of divisions was decided upon on a motion by Mr. MCMATH, whose figures showed this to be a good division by numbers.

A resolution was then adopted to the effect that all reports of special or standing committees shall be sent to the Secretary at least 60 days before the annual convention, and shall be printed and distributed to members at least 30 days before the meeting of such convention.

The business meeting then adjourned and a regular session was taken up, at which Mr. G. W. PEARSONS read a brief paper upon the "Syphons of the Kansas City Water-Works", which was supplementary to the description of the works printed in ENGINEERING NEWS, in November, 1887. The paper was briefly discussed.

The paper by Col. W. P. CRAIGHILL, "Some Observations on the Subject of the Improvement of Several of the Rivers of the Atlantic Coast", was then read by Mr. C. P. BURGWYN, U. S. Asst. Eng. It was quite long and might well have been condensed or abstracted, as such long papers cannot well be closely followed for discussion, as we have often pointed out. The paper was written in a manner which would be interesting to a man having leisure to read it for himself, but which made it too long to listen to. The actual points of professional interest and information could have been stated in half the time and would probably have brought out some interesting discussion, as there were several members present who were connected with river and harbor works; whereas it occupied the time of the meeting until the time of adjournment, and as might have been expected the subject fell flat when presented for discussion next morning and consequently no discussion was had. It is this sort of paper which makes the proceedings of the Society contrast unfavorably with those of the American Society of Mechanical Engineers, by which the papers are

printed and distributed before the Convention, abstracts read at the meetings, and the greater portion of the time devoted to discussions. An engineer does not care to sit and listen to a long paper which he could better understand by reading it himself, but he does care to get the expressions of opinions and experience of fellow members, such as would be given by discussion. The direct result of this paper was the unanimous adoption of a resolution presented by Prof. JOHNSON that during the remaining time of the Convention an abstract only should be read of papers which had been printed and had been distributed at the meetings. The meeting then adjourned.

In the evening there was a local reception at the Athenæum, held by the local members for the visiting members and guests of the Society. The elder and prominent members illustrated the laws of gravitation and attraction by their tendency to gravitate into corners and congregate in groups for the discussion of problems and the interchange of reminiscences. The dances were all professionalized as to title, including the "Gyrating Radii", the "Telephone", the "Electric", the "Torsional Twist and Centrifugal Whirl", and the "Sir John De Bogart".

On Saturday, June 30, a number of members gathered at the office of the City Engineer, Mr. BENZENBERG, at 8.30, and listened to some very interesting informal remarks as to the water supply and sewerage of the city. There was considerable discussion over some of the points presented, several of those present giving their own views and experience, and on listening to the animated and free discussion, one could not but regret that such freedom and general participation could not be introduced at the meetings, where on the contrary a certain amount of diffidence seemed to prevail.

The regular meeting opened at 10.00; (that is to say about 10.30.) Mr. Goodrich, President of the Society for the Advancement of Milwaukee, was introduced, and made a few remarks in presenting to the members a souvenir of the city. Mr. BRUSH, in a few appropriate remarks accepted the gift in the name of the members and was duly complimentary to the city and its citizens.

A paper by Mr. CLEMENS HERSCHEL on the "Venturi Water Meter," supplementary to a former paper, was then read by the Secretary and discussed by Messrs. MERRIMAN, FRANCIS, JOHNSON and LANDRETH. Mr. FRANCIS then read a few extracts from his paper on "High Dams," (which has been abstracted in full in ENGINEERING NEWS) and a short discussion followed. Mr. FTELEY stated that curved dams were built by French engineers, but they do not care to rely on the curve alone, but use it as an additional strength; he did not think curved dams suitable for long spans. Mr. FRANCIS said that a dam to be safe must be of a section sufficient to hold it by its own weight, and therefore a curved dam would add to the expense but not to the safety. The subject was further discussed by Messrs. COLLINGWOOD, JOHNSON and EDWARDS. A paper by Mr. DAGRON on the "Strength of Bessemer Steel Bridge Compressive Members" was read by title.

Four papers on brick-making, already presented to the Society, were then read by title, and the discussion of the subject opened by Mr. PURRINGTON, a brick manufacturer of Chicago. This was one of the best discussions of the convention, a large number of members taking part, and much interesting information and experience being brought to light. Mr. PURRINGTON stated that the art of brickmaking was in a very backward condition, but he looked for great advances in the future. He was glad to see that the Society was taking intelligent and practical interest in this question, and he thought it might aid considerably in the improvement of the art. We entirely agree with Mr. PURRINGTON on this point, as bricks are so much used in engineering works. He invited members to attend the annual meeting of the National Association of Brick Manufacturers, to be held at Memphis, NOV. 13, 14, and 15. The discussion was participated in by Messrs. DODGE, FRANCIS, DEMPSTER, MOORE, BENZENBERG, SEAMAN, GATES, JOHNSON, CONOVER and Prof. I. O. BAKER.

Prof. LINDERFELDT, Librarian of the Public Library, then made a few remarks on the subject of an international language, showing its advantages and referring especially to "Volapük", after which the meeting adjourned and the souvenirs were distributed. The souvenir consist of a large book of fine photographic views of the city, with a few pages devoted to history and description, handsomely bound in cloth and leather.

In the afternoon a large party boarded a special train, and were taken first to the extensive works of Messrs. E. P. Allis & Co., manufacturers of pumping and other machinery. Here was exhibited the large screw propeller, to be used for flushing the river which receives the discharge of the sewers. The propeller, which has four blades, the outer edges of which are made segmental, so as to fit close in a cylindrical casing, and which are mounted on a cylindrical hub, will be placed in the lake tunnel now under construction, and will force water from the lake through the tunnel into the river, creating a current to carry off the sewage. Thence the train proceeded to the locomotive and car shops of the Chicago, Milwaukee & St. Paul Ry. Co., and thence to the new works of the Milwaukee Cement Co., where a collation was served. The train returned to the city over the Chicago & Northwestern Ry. In the evening a complimentary performance of "The Bohemian Girl" was given at Schlitz Park, a resort conducted on the German plan, with large grounds illuminated with colored lamps, and having quite a large opera hall.

On Sunday, July 1, a number of members and guests visited the churches, and strolled about the city. The appearance of the yellow brick for buildings is very striking to those accustomed to red brick, and the former is much more pleasing to the eye. Owing to the grades of the streets being altered, the sidewalks are very irregular, being in many places high above the street level. The irregular round wood blocks which are used for paving the business streets are dirty, slippery and uneven. The residence suburbs of the city are very pretty, and there are many fine private residences. On the lake front, at the top of a bluff, is Juneau Park, from which there is a fine view of Lake Michigan. The appearance of the lake and of the city, however, is marred by the thick heavy black trails of smoke from the tugs, steamers and factories. The frequent opening of the drawbridges is a nuisance to traffic.

The morning session on July 2, which was the last meeting of the convention, was called to order considerably behind time as usual. Prof. J. B. JOHNSON announced that Washington University, St. Louis, Mo., proposes to undertake a series of tests of the strength of wooden beams, with a special view to obtain data which will be important for railroad purposes. A special machine is to be built, which will cost $2,500; of this about $1,000 remained to be subscribed and it is hoped that railroad companies will give their aid to so important a work. The machine will be built as soon as the money is subscribed, and the tests are expected to occupy about a year. The tests will be made with white pine, short leaf and long leaf pine, cypress and white oak; the beams will be of various sizes up to 18 ins. by 12 ins. by 24 ft.

The Secretary then read a paper by Mr. WILLIAMS on the "Plant and Machinery of the Panama Canal". At the early part of the work the company owned the dredges and they were run by the contractors. This was very unsatisfactory, however, as the contractors would use the company's plant to its full capacity, making no repairs, and when the machine broke down from any cause, however slight, it was side tracked at once and a requisition made for another. Under present arrangements the machines are owned or leased by the contractors and are worked night and day, but are overhauled and repaired on Sunday. They average about 100,000 cu. yds. per month; one dredge made 237,000 cu. yds, in a month, but it was in stuff that had slipped back into the channel and was very easily removed. At first, when operations were commenced at numerous places and only light work was encountered, a large amount of plant was needed, but now that the work is more difficult, and consequently slower, there is a quantity of valuable plant lying idle and useless, rapidly deteriorating, because there is not room for it to be put to work. The climate is deadly, consequently contractors try to make the largest amount of money in the shortest possible time, so as to be able to escape to a more healthy climate to enjoy their profits.

The dredges in use are of American, Scotch, French and Belgian manufacture. The American dredging company has fine repair shops at Gatun, and keeps its plant in good condition, enabling it to do constant hard work. The Scotch dredges are self propelling and sailed out from Scotland, one of them across to the Atlantic end of the canal, the other going round Cape Horn to the Pacific end. The French dredges are sent out in sections and erected on the isthmus; they cost about $100,000 delivered at Colon; this does not include their erection at Panama, which is very expensive. For the contractors' tracks a 70 lb. rail is used, with a height exceeding the base, and the locomotives overturn the rails, drawing the spikes. For these tracks a 40 lb. or 50 lb. rail, with a base equal to the height, would have been sufficient. Mr. WILLIAMS hopes later to give a detailed paper on the dredging plant of the canal.

Mr. J. R. WARDLAW read a paper describing in detail the operation of moving back the Brighton Beach Hotel at Coney Island, N. Y. This work has been described in ENGINEERING NEWS, and consisted in jacking up the building and supporting it on flat cars, and then hauling the entire structure with the aid of locomotives.

Mr. H. B. SEAMAN then read a discussion on the paper on "Inspectors and Bridge Work", by Mr. S. T. WAGNER, which paper was read at the convention of 1887. He thought the paper had not been sufficiently discussed. The present system of inspection is unsystematic and and unsatisfactory. An inspector is not an engineer and should not be expected to do an engineer's work; his duty is to see that the work is done in accordance with the specifications, and not to look out for errors. Mr. SEAMAN thought that every shop should be able to turn out good work without the inspection of outside parties.

Mr. D. J. WHITTEMORE read a discussion on the paper by Mr. C. L. STROBEL on "Z-Iron Columns", which was read before the Society during the past year. Mr. WHITTEMORE had not at first favored this form of column, but after investigating its design he permitted its use on some work being done under his supervision, and was satisfied with the result. He alluded to the fact that all the parts are outside of the "pool" of manufacturers of angles and channels. In conclusion he suggested that as the column is a valuable design, and one of considerable importance, it should be technically known as the "Strobel" column, which suggestion was loudly applauded.

A paper on "Maintenance Expenses of Track on Wooden and Metal Ties", (which was abstracted in ENGINEERING NEWS, June 30), which had been presented to the Society by Mr. J. W. POST, Engineer of Permanent Way of the Netherland State Ry. Co., was read by title, and a discussion upon it was read by Mr. E. E. RUSSELL TRATMAN. He referred to the systematic experiments conducted by Mr. POST for several years past, the result of which has been the designing and general adoption of the rolled steel tie universally known as the "Post" tie, which is rolled with a variable section, giving extra thickness at the rail seat, and which has proved very satisfactory in service, besides being easy to manufacture. The early forms of ties gave way by cracking between the holes for the fastenings, and if made thick enough to prevent cracking, they were too heavy and expensive. With the "Post" tie extra strength is given where needed without an undue increase in weight. General experience has shown that the ends should be closed, in order to prevent lateral displacement; but open end ties are still used. Steel ties should be used as the standard for first-class track to carry heavy traffic, and not merely as a substitute for timber when the latter becomes scarce or expensive. For instance such a line as the projected New York and Boston direct line, which would start with a constant and heavy traffic, should be laid with steel ties in the first place. He had been making some investigations as to the use of these ties in foreign countries and had been surprised at the great extent to which they had been adopted for regular service. The results of experience have been in the main satisfactory. The introduction of steel ties has been hampered by the attempt to make a cheap tie; but the objects in using steel are to obtain economy in maintenance and efficiency in operation, neither of which can be obtained by using a tie which is cheap. Every point of perfection cannot be combined in one piece of steel, and if the steel tie is to make the track safer, reduce maintenance expenses, keep the road in better condition and outlast the wooden ties, it must have sufficient metal to insure these advantages. The tie should be economical, but a cheap tie does not result in economy. The design and manufacture are equally as important points as the weight, and the rail fastenings no less important. In nearly every large country but America, and in many of the smaller countries, metal ties have been experimented with and adopted, and Mr. TRATMAN suggested that more practical attention ought to be paid to so important a matter by American engineers and steel manufacturers.

This practically closed the business portion of the convention. The Secretary read a circular from the Committee on the Building Fund, requesting subscriptions from corporations and private parties outside the profession. There has been a sufficient amount subscribed for enlarging the present house of the Society, but it is proposed to build a new house, with better and safer accommodations for the valuable documents in the possession of the Society, many of which if lost could never be replaced.

Mr. J. J. R. CROES moved a vote of thanks to the Womans Club and the Athenæum Association for the many courtesies tendered. Mr. A. FTELEY moved a vote of thanks to the city and the press for their warm reception of the Society. Mr. COHEN moved a vote of thanks to the local committee, and Mr. ROBERTS moved a similar vote to the Chairman, Mr. GEO. H. BENZENBERG, who after a few remarks moved a vote of thanks to Mr. D. J. WHITTEMORE, which was carried with three cheers. Mr. BRUSH moved a vote of thanks to the Society for the Advancement of Milwaukee, the Milwaukee Club, E. P. Allis & Co., the Chicago, Milwaukee & St. Paul Ry. Co. and the Milwaukee Cement Co. All these were carried unanimously and the meeting then adjourned.

In the afternoon the party was taken for a carriage drive round the city, visiting the water-works pumping station and the extensive brewery of the Best Brewing Co., returning by way of the Soldiers' Home.

In the evening the banquet was held in the dining hall of the Plankinton, and was successfully managed. The speeches in response to the several toasts were of an interesting and entertaining character, and the proceedings were diversified with vocal music.

On July 3, the party started at 9 A. M. for Appleton, the Milwaukee & Northern Ry. Co. furnishing a special train for the run of 107 miles. At Appleton the paper mills were visited, where wood blocks are ground to pulp for "stock" from which the paper is made, and where the series of operations of manufacture were observed with interest. At one of the mills a chemical process is employed which reduces the wood to pulp without destroying its fibre, thus making a stronger paper than the ground pulp. After a walk to the large dam the electric street railway cars conveyed the party to the hotel for dinner. This railway is on the Van Depoele system with overhead wires. After dinner the electric cars took the party to the stern-wheel steamer *Evalyn* on which an interesting ride of 10 miles was taken down the Fox river, passing through 4 or 5 sets of locks, to Kaukauna, a small town which is boom-

ng for water power and has no intention of remaining small. There are already some water power dams at this place and others are to be built. A thoughtful local committee had provided a supper at the hotel, which was done full justice to by a hungry party. In the evening a special train carried the party back to Milwaukee over the Milwaukee, Lake Shore & Western Railway.

On July 4 an excursion was made to Oconomowoc and Waukesha, and in the evening the party viewed the display of fireworks at the National Soldiers' Home. On July 5 the special train for New York carried away the greater number of the Eastern contingent, while a party started North for Escanaba (where are extensive ore docks) Sault Ste. Marie and other points. At Sault Ste. Marie there is much to interest engineers: the large Government lock which enables vessels to pass the rapids, and has a lift of about 18 ft., the gates being operated by hydraulic power; the work just commenced for the new lock, where a large boom dredge belonging to the contractors, Carkin, Stickney & Cram, of East Saginaw, is dredging out boulders and gravel; the ten span bridge over the river, built last year by the Dominion Bridge Co.; the drawbridge over the canal, about 400 ft. long, built last year by the Detroit Bridge & Iron Works; and the drawbridge provided with gates which can be lowered to shut off water from the lock. There is also submarine drilling and blasting going on for the work of deepening the canal; the steam drills are mounted on frames on a large scow, and dynamite charges are fired in the holes. The city has raised money to guarantee the construction of the water power canal, and being well located for receiving grain from the west, it is expected that elevators and mills will be established.

In the convention hall was a specimen of the rail joint used on 3,000 miles of the C. M. & St. P. Ry.; the rails weigh 75 lbs. per yard, and have a pair of 40-in. angle bars with 6 bolts; a tie is placed under the joint. A model of the "Continuous" rail joint, recently described and illustrated in ENGINEERING NEWS, was exhibited; also a specimen of the "Long" spring truss rail joint. (Apropos of rail joints, the new Minneapolis, Sault Ste. Marie & Atlantic Ry., an interesting road over which some of the party traveled, is using the Samson splice bar with satisfactory results). The other exhibits were an illuminated plumb bob for mining work, and a number of transparent set squares, curves, etc., which were examined with much interest.

In concluding our report of the convention we would again call attention to the importance of affording ample time and opportunity for discussions; and also to the importance of punctuality in opening the meetings. If members knew that the meetings would be opened sharp at the stated hour they would learn to be on hand, but as it is at present each man knows that punctuality is not observed by the officers, and therefore does not trouble himself to be punctual. These are two points in which radical reform is needed, and we hope the lesson will be learned in time for the convention of 1889.

CONSTRUCTION NEWS.

RAILROADS.

East of Chicago.

Existing Roads.

Pennsylvania.—The company is to appropriate $285,000 to the improvement of the Altoona shops. A paint shop and round house will be built this summer. It is announced that the company will use every endeavor to secure the use of the Arthur Kill bridge in common with the Central of New Jersey.

New York & New England.—The 13-mile extension of the New Haven & Derby road is being pushed by 800 hands.

New York, Pennsylvania & Ohio.—The contract for the new shops at Brier Hill near Youngstown, O., has been let to Drake, Shattuck & Co., the work to be finished by Nov. 1.

McKeesport & Belle Vernon.—Grading is being rapidly pushed on this road running south from Pittsburg, Pa. It is to be extended from Belle Vernon to Fayette City.

New York, Mahoning & Western.—An election was held at Ft. Wayne, Ind., on July 7, and $200,000 was voted to this company on condition that its repair shops be located at that point.

Philadelphia & Reading.—The extension of the Camden, Gloucester & Mt. Ephraim road at Camden, N. J., has been opened for traffic.

New Projects and Surveys.

Brookfield.—I. J. GRIFFITH, of Utica, N.Y., will build this short 6-mile line in the town of Brookfield, N. Y., the filing of a charter for which was recently noted.

Negaunee & Palmer.—This company has been incorporated in Michigan to build a road between the points named, a distance of about 10 miles.

SOUTHERN

Existing Roads.

Georgia, Carolina and Northern.—A correspondent corrects our record of the tracklaying on this road, given in our issue of June 23. Track was laid up to June 30, from Monroe to the Catawba River, 22¼ miles, of which about 13 miles are in North Carolina, and 9¼ miles in South Carolina. The bridge across the Catawba river is being built by the Edge Moor Iron Co. of Wilmington, Del., and is nearly ready for the rails. It has four 150 ft. spans. FRED. H. SMITH is the engineer. The track is expected to reach Chester, 44½ miles from Monroe, in the latter part of September.

Savannah, Florida & Western.—The city council of Savannah, Ga., have granted the company permission to erect a new passenger depot at the corner of Liberty and East Broad Streets. Work is to begin at once.

Kentucky Midland,—The directors of this Kentucky Company have let the contract for construction to Mason, Gooch, Hoge & Co., for the line from Frankfort to Paris. The division from Frankfort to Georgetown is to be completed in one year from date and the whole line to Paris by Nov. 1, 1889. The distance from Frankfort to Paris is 40 miles, and the estimated cost is $22,000 per mile. Ground was broken on the line near Frankfort on July 5, and the contractors will push grading at once.

Kentucky Union.—Commissioners have been appointed to assess the damages for right of way from Winchester to Hedges. The contract for 81 miles of the line is reported let to MASON & Co. F. D. CARLEY, of Louisville, is President, and W. A. GUNN, of Lexington, is Chief Engineer.

New Projects and Surveys.

Owensboro, Falls of Rough & Green River.—The surveys are in progress on this road, under direction of J. N. ALSOP. A. C. TOMPKINS, of Owensboro, is President.

Hawkinsville.—A scheme is on foot at Hawkinsville, Ga., to build a railroad to Fullington's Mill, on the Georgia Southern & Florida, a distance of 18 miles. An offer has been made to build the line for a subsidy of $50,000, which Hawkinsville is trying to raise.

Huntington & Guyandotte River.—This company has been organized at Huntington, W. Va., with J. L. CALDWELL, President, and EDWARD ILSLEY, Secretary and Treasurer. WM. HARRIS, who has made a reconnoissance survey of the line from Huntington to Logan C. H., reports a favorable route.

Bowling Green & Northern.—This Kentucky company perfected its organization at a recent meeting at Bowling Green, choosing J. M. WILKERSON J. PROCTOR KNOTT, HUNTER WOOD, C. G. SMALLHOUSE, HUGH BARCLAY, and others directors. A proposition for $150,000 aid will be submitted at once to Warren County.

St. Albans & Coal River.—This company has been chartered in Charleston, W. Va., to build a railroad from St. Albans, on the Great Kanawha river, to coal beds in Raleigh County. WM. M. PEYTEN and PETER FONTAINE of Charleston, W. Va., and SAMUEL W. JORDAN and JOHN S. CUNNINGHAM, of St. Albans, are among the incorporators.

Atlantic, Tennessee & Western.—This road is to run from Elizabethton, Tenn., to Carter's Furnace, W. A KITE is making surveys.

Richmond & Seven Pines.—Organized at Richmond, Va., to build a railroad 8 miles in length. A. G. BABCOCK is President, and O. B. MURPHY, Secretary and Treasurer.

THE NORTHWEST.

Existing Roads.

Sault Ste. Marie & Southwestern.—It is reported at Eau Claire, Wis., that President N. C. FOSTER, of Fairchild, Wis., has secured $6,000,000 for the purpose of building this line to the Sault Ste. Marie. Considerable work has already been done on the surveys and about 14 miles of the line were opened to traffic last year.

St. Louis & Chicago.—This company and the Mt. Olive Consolidated Coal & Coke Company have filed a mortgage to the Holland Trust Company of New York, to secure $1,000,000 of 40 year bonds, the bonds to be applied to the general improvement of the property.

New Projects and Surveys.

Chicago, St. Louis, Kansas City & Galveston.—This company has been incorporated in Illinois by FRANCIS E. HINCKLEY ROBERT D. FOWLER, E. T. HOUSE, C. E. FUDGE and JOSEPH LATHROP, of Chicago, to build a railroad from Chicago to a point opposite Hannibal, Mo. It is supposed that the same interests are behind this that are back of the Chicago, Hannibal & Springfield Company, which made surveys for a line from Hannibal, Mo., southwest last spring.

Chicago, Mattoon & Cairo.—This company has been incorporated in Illinois to build a line from Chicago to Cairo, Ill., *via* Mattoon. The incorporators are O. A. ALLAN, FRANK KOERN, JAS. H. CLARK and JOHN F. SCOTT, of Mattoon.

THE SOUTHWEST.

Existing Roads.

Ft. Worth & Rio Grande.—This Texas company expect to begin work by August 1 on the extension from Granbury to Brownwood, 108 miles.

San Antonio & Aransas Pass.—In reference to the proposed 60 mile extension through Llano and Gillespie counties to Llano City, President LOTT has agreed that if the roadbed shall be graded, the company will build bridges and culverts and lay the track. It is stated that the proposition will be accepted.

Chicago, Rock Island & Pacific.—The following is a statement of the track laid during the first six months of the current year on the extensions of this company's system:

Norton, Kan., to Goodland, Kan	105.8 miles
Kingsdown, Kan., to State line	84.2 "
Kansas Line to Pond Creek, Ind. Ter.	20.0 "

New Projects and Surveys.

Memphis, Little Rock & Indian Territory.—This company has been chartered in Arkansas. The proposed line extends from Little Rock to Hot Springs and thence to the Indian Territory line by two branches, one running west and the other southwest, a total distance of 320 miles. The incorporators are BENJ. E. ORR and GUSTAVE A. J. MILLAR of New York; FRANK F. SMITH and JAS. F. FAGAN of Little Rock; and JOHN J. SUMPTER of Hot Springs.

Platt, Salt Plains & Rio Grande.—This company has been incorporated in Kansas to build a railroad from Pratt, Kan., to El Paso, Tex., a distance of 600 miles. T.E. SIMPSON and GEO. H. SAUNDERS of Pratt, and J. M. GRAHAM of Englewood are among the incorporators.

ROCKY MOUNTAIN & PACIFIC.

Existing Roads.

Southern Pacific.—Four new branch lines were opened for traffic on July 1. The Capay Valley branch of the Northern California division, from Madison to Ramsey, 23.7 miles. The San Joaquin division from Tracy to Newman, 37.1 miles. The Fresno division, form Fresno to Porterville, 69.3 miles. The Mendocino branch, from Willows to Frato, 17.1 miles. It is announced that the company contemplates the construction of a bridge across Carquinez straits where trains are now transferred by boat. The width of the straits is between 3,500 and 4,000 ft., and it is proposed to place the bridge at a sufficient height to avoid obstruction to navigation. Borings are now being made on the proposed site.

Northern Pacific.—It is reported that the branch which was built in 1886 from Hauser Jc. to Cœur d'Alene City is to be extended around the lake to Mission, the terminus of the Cœur d'Alene Ry. & Nav. Co.'s narrow gauge line, which is to be purchased. D. C. CORBIN is the principal owner.

Mexican National.—The recent heavy floods did serious damage to the partially completed grade of this line and to many bridges.

Park & Cliff House.—This short suburban road at San Francisco is completed and is now open for traffic.

Chicago, Kansas & Nebraska.—Articles of incorporation have been filed in Colorado consolidating with this company the recently chartered Chicago, Rock Island & Colorado company, being the lines of the Rock Island system in Colorado.

New Projects and Surveys.

Port Townsend Southern.—This Washington Territory company are securing heavy local aid, and land subsidies, and will soon attempt to enlist outside capital in their enterprise. Surveyors are already at work on the line as announced last week. The road is projected to run from Port Townsend, W. T., to Portland, Ore. L. B. HASTINGS of the former place is Vice President.

Contracting.

Tunnel.—At Newport Ky., the contract for the construction of the tunnel at the water-works has been awarded to Dennis J. Slattery.

Electric Lighting.—At London, Ont., the following proposals for electric lighting have been received: Bell Electric Light Co., 25 cts. per light per night; Hunt Bros., 27 cts. for 9½ ampere lights, 25 cts. for 8 or 8½ ampere lights. The contract was awarded to Hunt Bros. Three lights will be established at Victoria Park.

Masonry Dams.—The contract for building masonry dams, Nos. 1 and 2, for the Bound Brook Water Co., was, on July 11, awarded to L. Wright, of Newtown, Conn.

Dummy Railroad.—The contract for the construction of the motor line from Huntsville, Ala., to Monte Sano, has been awarded to Arthur, Owen, Wilson & Co., of Huntsville, at $100,000.

Stop-Cocks.—The Aqueduct Commissioners, New York City have awarded a contract for two 48 in. stop-cocks to Caldwell, Wilcox & Co., at $1,950 each, and $300 each for all the work and putting the valves in place.

Mill.—The Parsons Paper Co., of Holyoke, Mass., has awarded the contract for building the new mill near Sargeant St. to Lynch Bros, and work has begun. It will require 7,000,000 or 8,000,000 brick.

Jail.—The Pauly Jail Building & Mfg. Co., of St. Louis, Mo., has the contract for a $13,000 jail at Canadian, Tex.

The Street Railway Construction Co. has been incorporated by JOHN A. BOWERS, of New York, E. W. VAN BRUNT, of Red Bank, N. J., and H. W. TILLINGHAST. Capital stock $20,000.

The Assembly Chamber Ceiling.—The contract for replacing the stone arched ceiling of the assembly chamber at the capitol, Albany, N. Y., with an iron and wood ceiling, has been awarded to JOHN SMITH.

Sewer Brick.—At Holyoke, Mass., the Committee on Sewers has awarded the contract for brick for the extension of the Jackson Street sewer to GEO. W. RICHARDS & Co., at $8 per 1,000.

Depot.—The Savannah, Florida & Western Ry. Co. will build a new depot at Savannah, Ga. Work will be commenced at once.

Dredging.—There is about 50,00 cu. yds. of dredging to be done at Conneaut, O., for the Pittsburg, Shenango & Lake Erie R. R. Address WYNDHAM C. JONES, Chief Engineer, at Conneaut.

Viaducts.—At Chicago, Ill., bids will shortly be invited for the construction of the Dearborn St. viaduct, which will be 40 ft. wide, having a 28 ft. roadway and two 6 ft. sidewalks. City Engineer NORTHWAY hopes to have the work all completed before the winter sets in, when work will be commenced on a double railway bridge at Clark St. Bids will also be invited on the Twelfth St. and Fifth Ave. viaducts.

Water-Works.—***Chadron, Neb.***—Contracts have been awarded as follows: machinery and boilers, Holly Mfg. Co., Lockport, N. Y., $5,930; pipe and specials, National Tube Works, Chicago, Ill., $22,906.95; John Moll, Chadron, engine house, $1,100; well, $280; laying pipe, $4,580; Galvin Brass & Iron Works, Detroit, Mich., hydrants and valves, $1,830; James Cavenaugh, Chadron, Neb., reservoir, $1,300.

Street Work.—At Lincoln, Neb., a contract for alley paving has been awarded by O. N. GARDNER, City Engineer, to T. R. Sylvanus at the following prices: Colorado sandstone on sand, $2.52 per sq. yd. complete; Sioux Falls sandstone on sand, $2.66 per sq. yd. complete; Woodruff granite on sand, $2.47 per sq. yd. complete; extra grading, 30 cts. per cu. yd.; extra sand, $1.25 per cu. yd.; Colorado stub curb, 15 ins. × 4 ins., 40 cts. The contract will amount to $45,000.

Wharf Work—At San Francisco, Cal., the Harbor Commissioners have received the following bids for removing the wharves in the line of Section 7 of the sea wall, and for building and removing temporary connecting railways for the Jackson and Washington St. piers: San Francisco Contracting Co., $3,997; American Bridge & Building Co., $5,800; San Francisco Bridge Co. $3,923; B. McMahon & Sons, $4,150. All these bids were rejected. The proposition of the San Francisco Bridge Co., to do the work for $2,500 was accepted by the Commissioners.

Proposals Open.

Street Work.—Street grading. G. W. PINKERTON, Clerk, Street Committee, Lancaster, Pa. July 16.

Railway Work.—Grading, tunnel excavation, masonry and ballasting on 15 miles of the Baltimore & Harrisburg Ry. J. M. HOOD, President, Western Maryland R. R. Co., Hilen Sta., Baltimore, Md. July 16.

Railway Shop.—Paint shop and transfer pit at Altoona. W. H. BROWN, Chief Engineer, Pennsylvania R.R., 233 So. 4th St., Philadelphia, Pa. July 16.

Street Work.—THE COMMISSIONER OF PUBLIC WORKS, 31 Chambers St., New York City. July 17.

Building.—Public library. Architects, MCKIM, MEAD & WHITE, 30 Beacon St., Boston. THE TRUSTEES OF THE PUBLIC LIBRARY, Boylston St., Boston, Mass. July 17.

Macadamising.—Jackson Ave. Engineer, J. J. MCLAUGHLIN, Atlantic Ave. and Wyona St., Brooklyn. THE BOARD OF SUPERVISORS OF QUEENS COUNTY, Long Island City, N. Y. July 17.

Sewers.—PERCIVAL ST. GEORGE, City Surveyor, Montreal, Canada. July 18.

Canal.—About 500,000 cu. yds. earth and rock excavation; large quantities of piles and timber. JOSEPH CLARK, President, St. Mary's Falls Water Power Co., Sault Ste. Marie, Mich. July 18.

Bridge and Abutments.—Masonry in cement, 102 cords in each abutment. Iron bridge, 125 ft. span, 18 ft. roadway; also wooden Howe truss bridge, 125 ft. span, 17 ft. roadway, 4½ ft. sidewalk. J. A. LATHAM, C. E., 45 Westminster St., Providence, R. I. July 18.

Pipe.—Wood and iron pipe for water-works. 500 ft. of 12-in., 500 ft. of 10-in., 9,000 ft. of 8-in., 11,000 ft. of 6-in.; for fire pressure of 200 lbs., also bids for 300 lbs. pressure. GEO. C. PIERCE, Town Clerk, Ouray, Col. July 21.

Street Work.—Vitrified brick paving. JOHN H. BEST, City Clerk, Zanesville, O. July 21.

Street Material.—Asphalt tile, asphalt blocks, granite blocks, curbing and brick. C. W. RAYMOND, Engineer Commissioner, Washington, D. C. July 21.

Pumping Machinery.—Daily capacity, 10,000,000 galls. Bids to include connections, etc. H. C. WOLF, Superintendent of City Water-Works, Sacramento, Cal. July 23.

Street Work.—W. P. RICE, City Engineer, Cleveland, O. July 26.

Canal Work.—Work on 7 locks on the Erie canal; also dredging 140,000 cu. yds, at Albany basin. JAMES SHANAHAN, Superintendent of Public Works, Albany, N. Y. July 31.

Bridge.—Iron bridge over Rock creek. C. W. RAYMOND, Engineer Commissioner, Washington, D. C. Aug 31.

Bridges.—Repairing 4 bridges. J. T. COOPER, Clerk of Fulton Co. Commissioners, Savannah, Ga. Aug. 1.

WATER.

San Luis Obispo, Cal.—The Trustees have granted a franchise to the Petroleum Gas Co., in spite of the opposition of the old gas company.

Oakdale, Cal.—The Oakdale Irrigation Co. has decided to commence work at once on the construction of its ditch.

Philadelphia, Pa.—The Health Board is having notices served on property holders and mill owners along the route of the intercepting sewer to have connections made with this sewer instead of discharging their sewage into the Schuylkill. In most cases a collecting basin will have to be built, from which the sewage will be pumped up to the pipe leading to the sewer.

Colorado Springs, Col.—McShane, Clough & Moore, the sewerage contractors, began work on the system July 5, with a force of 20 men, which will be rapidly increased. The City Marshall proposes to put all the tramps who can be found at work on the sewers. An additional policeman will be added to the day force for this purpose.

Pecos, Tex.—Work has begun on the irrigating ditch, and will be vigorously prosecuted. The present force will be increased to 100 men. Rapid progress will be made. The ditch will, by 1889, furnish 200 farmers with water for irrigating purposes.

Woodstock, Ont.—The city is destitute of street lighting. The contract with the gas company expired July 1, and has not been renewed.

Buffalo, N. Y.—Work is progressing on the enlargement of the water tunnel and inlet shaft. The latter is 4 ft. in diameter and is being increased to 6 ft.; this is done by drilling holes at a distance of 1 ft. from the edge of the shaft, and breaking out the intermediate rock. The rock is 16 ft. deep, and there is a depth of 17 ft. of water flowing with a rapid current. John Hickler is the contractor. The work on the tunnel and shaft will cost the city $21,800, and will result in doubling the capacity of the tunnel. New mains, 36 ins. diameter, are to be laid to give an increased supply to East Buffalo. During the work on the tunnel the water supply is taken from the old, or Bird Island, inlet pier. LOUIS H. KNAPP is Superintendent.

Sault Ste. Marie, Mich.—At a citizens' mass meeting on July 3, $12,000, the remainder of the sum necessary to insure the commencement of work upon the great water power canal was raised. This makes $100,000 raised by the citizens, for which they receive from the water power company $20,000 in stock. The company agrees to put up a like amount and to begin the the work of construction within 30 days. The plans and specifications for the canal are now in the hands of the contractors and there will be no delay in beginning the work and pushing it on to completion. The canal will be 3 miles long and is estimated to cost about $700,000. An effort will be made to complete it within 15 months. This move means the development of one of the greatest water powers in the world and is expected to result in making the city a manufacturing place of considerable importance. Many applications for power have already been received.

Water-Works.—***Connecticut.***—Bridgeport. A committee of the Common Council has reported resolutions for the improvement of the water supply and the establishing of blow-off valves by the water company.

New York.—Little Valley. The gravity system of water-works is nearly completed.——Fairport. Water-works are to be put in.——Honeoye Falls. The new works are completed.

Pennsylvania.—Philadelphia. An ordinance has been recommended to be granted to the Duquesne Water Co., including an exclusive right to supply water for elevators for 30 years.——Greensburg. Water-works will be built.——Mt. Pleasant. The town council has accepted the offer of the Mt. Pleasant Water Co., at $32.50 for each of the first 50 plugs.——Lebanon. Investigations as to a water supply are to be made by ISAAC CASSIN, C. E., of Philadelphia.——Monongahela City. Pipe is being distributed and a site selected for the reservoir.

Virginia.—Berkeley. The town has asked the Portsmouth & Lake Drummond Water Co. to extend its system to this place.

Tennessee.—Guthrie. Water-works will be built by the Louisville & Nashville R.R. Co. The supply will be taken from springs and pumped to a stand-pipe. Fire plugs will be maintained free of charge to the town. Dr. W. D. MERIWETHER is interested.

Alabama.—Sheffield. The capacity of the water-work plant is barely sufficient for present needs, owing to the rapid growth of the city, and the water company will put in new pumping plant.

Michigan.—Grand Rapids. Another effort will be made to have the people vote $150,000 for extending the water-works system. The council will order a special election at its next meeting. If the vote is against the issue of the bonds the system will probably be sold to a private corporation.—Battle Creek. The water-works are to be extended.

Illinois.—Peoria. Moffett, Hodgkins & Clark, of Watertown, N. Y., have made a proposition to put in water-works. It has been referred to the Water-works Committee.

Wisconsin.—Marinette. Pipe is being laid across the bed of the river and the pumping station is being erected.

Kansas.—Kansas City. An ordinance has been introduced in the city council to grant a franchise to a local syndicate headed by ISAAC LA GRANGE, for the construction and maintenance of a water-works system. It has been discovered that there is nothing in the franchise of the old water company, to prevent the operation of another enterprise.

Nebraska.—Aurora. On July 2 the vote on the proposition to issue bonds for $25,000 for a system of water-works was almost unanimously in favor of the issue.

Washington Territory.—Spokane Falls. The city council has ordered a new plant for the water-works at a cost of $43,100. A new site for the plant is to be purchased.——Walla Walla. Fire plugs are being set at street corners.

RECORD OF NEW WATER-WORKS CONSTRUCTION.

(Specially Communicated.)

(CONTINUED FROM PAGE 22).

Wiarton, Ont.—The works were commenced in the spring and are to be completed this month. The contract for the entire work, except pumping house, has been let to John D. Ronalds, of Brussels, Ont., the town doing the masonry, foundations and buildings. The water is taken from Georgian Bay and pumped direct by a Worthington, duplex, horizontal, double acting pump of 750,000 galls. daily capacity. There are 3,500 ft. of pipe and 8 hydrants; the mains are of cast-iron, and the services of galvanized iron. Ordinary pressure, 40 to 50 lbs.; fire pressure, 125 lbs. Cost of works, $8,000: debt, $8,000; rate of interest, 6 per cent. The works are owned by the town. Present population, 2,000.

Belfast, Me.—The works were commenced in June, 1887, and the water was turned on Dec. 1, 1887. They were designed and built by Wheeler & Parks, of Boston, Mass., who sublet contracts as follows: for pumping machinery, Deane Steam Pump Co., of Holyoke, Mass.; for pipe and specials, Builders' Iron Foundry, of Providence, R. I.; for trenching and pipe laying, Ferris & Halladay, of Jersey City, N. J.; for valves and hydrants, Coffin Valve Co., of Boston, Mass.; for tank, E. Hodge & Co., of East Boston, Mass. The supply is drawn from Little river and pumped to a tank 30 ft. diameter and 45 ft. high, by one pump of 1,000,000 galls. daily capacity and one compound steam pump of 750,000 galls. daily capacity. There are 8¼ miles of pipe, 45 hydrants, 125 taps and 4 meters; the mains are of cast-iron and the services of enamelled wrought-iron. The pressure is about 80 lbs. The franchise is for 20 years and the hydrant rental $45 per hydrant per annum. The works are owned by the Belfast Water Co.; President, C. J. GILMAN; stock, $100,000; bonds, $65,000. CHAS. BAKER is Superintendent. The present population is 5,800.

Marinette, Wis.—The works were commenced in the spring and are to be completed this season. They were designed by H. J. HILBERT, of Milwaukee, Wis., and C. D. BARSTOW is Constructing Engineer and Superintendent. The contractor for masonry, foundations, buildings, trenching and pipe laying, is A. W. Stevens, of Logansport, Ind.; for pumping machinery, Deane Steam Pump Co., of Holyoke, Mass.; for pipe and specials, R. D. Wood & Co., of Philadelphia, Pa., and Addyston Pipe & Steel Co., of Cincinnati, O.; for valves and hydrants, Ludlow Valve Mfg. Co., of Troy, N. Y. The supply is drawn from Green bay and pumped direct into the mains. There are 14¼ miles of wrought-iron and cast iron pipe, and 125 hydrants. The cost of the works is estimated at $155,000; rate of interest, 6 per cent. The franchise is for 20 years and the hydrant rental $46 per hydrant per annum. The works are owned by the City Water-Works Co., in the interest of the American Water-Works & Guarantee Co. The stock is $200,000; bonds, $125,000. The present population is 12,500.